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CONTENTS.

Editorial	1181
The German Electrical Industry	1184
Light and Illumination	1185
Constant-Current Generator	1186
High-Potential Line Insulator	1186
Mercury-Vapor Wireless Detector	1186
Electric Cooking Cost Data	1187
Resistance Leads for Commutator Motors	1187
Double-Wound Alternating-Current Commutator Motor	1187
Cooperative Electrical Development Association	1188
Current News and Notes	1188
Hydro-Electric Developments at Huntingdon, Pa	1191
Present Status of European Practice in Transmission Line Work	1194
The Design of Induction Coils. By Wm. O. Eddy and Melville Eastham	1197
The Single-Phase Induction Motor.—III. By Alfred Still (*Concluded*)	1202
New Telephone Patents	1205
LETTER TO THE EDITORS:	
Wireless Telegraph Receiver. By Lee de Forest	1206
Digest of Current Electrical Literature	1206
Book Review	1209
The Plant of the American Spiral Pipe Works, Chicago	1209
Sixty-five Mile Interurban Line in Texas	1211
Automatic Starter for Induction Motors	1212
Corner Drill for Wiremen	1212
Industrial and Commercial News	1213
General News	1217
Weekly Record of Electrical Patents	1223

AN APOLOGY.

We desire to offer our readers an apology for the serious delay in the circulation of our issue last week, although the fault, so far as we can determine, is in no sense ours. The issue contained the Moonlight Schedule for central stations, published by us for many years past, and annually, as a guide for managers in their contracts for lighting 50,000,000 people, and prepared carefully by one of their own number. It is an integral part of the paper, strictly pertinent to its news function, but for convenience of the recipient is printed in small broad-sheet form so that it can be posted up in the power house for constant reference. It brings us no revenue. It is not advertised, and it advertises nobody's business. It is prepared at considerable cost, and is valued by 5,000 central station managers because of its accuracy. It was, as usual, indexed in our "contents" and discussed editorially. We know to-day of no possible legal or legitimate construction whatever that could make it postal contraband, yet last week our whole edition was confiscated in the New York Post Office because of it, every copy was thrown out, every copy had to be brought back, unwrapped, opened, relieved of its pernicious supplement, readdressed, and remailed, without the supplement that it said was contained therein. Meantime the supplement has been placed in special envelopes, addressed and remailed separately, as promptly as the post office will allow—and that is mighty slowly—to our readers, who have been wondering and complaining.

The only explanation of this Cossack procedure is that last January the local New York Post Office stated to some one that it would not allow the Moonlight Schedule to go forward again as a supplement, and apparently the inept reason for that attitude was the possibility that daily papers might as well mail calendars to their subscribers! Inquiry and investigation develop the fact that this unacknowledged official warning was received by a subordinate employe—not an officer—of this paper, who left its service months ago, and who never even mentioned its receipt to any one else in this office. His estimate of its value and sanity was probably correct, but even if it had been duly acknowledged, that is no sufficient or even plausible reason or excuse for the intolerable delay inflicted on our readers, who are made to suffer because we sought to do them a wholly unpaid and disinterested service. Incidentally, as to calendars, there seems no good reason why they should not be a newspaper supplement. The *Courier des Etats Unis* has had an excellent one for years, and we believe many others could be listed.

For ourselves we are sick and heartily tired of the whole Post office régime that thus incessantly blocks the road of progress and of public service, and that not content with petty annoyances of this character now proposes to increase postal rates on trade and technical publications 400 per cent! We invite the careful attention of President Roosevelt and his new Postmaster-General not only to such rulings and embargoes, but to the extravagant railroad contracts that render it necessary to impose vexatious rates and burdens on the dissemination of knowledge and the cultivation of commerce, and that after all, land the Post Office De-

partment in fictitious bankruptcy. The sooner such an investigation comes the better for the real interests of the country. We shall return to that subject with data, but for the present, limiting our apology to the case in hand, we wish simply to say that the fault is not ours for the delay, that the Post Office has absolutely no right to impose such arbitrary rulings on us, that such rulings are fantastic, and that as an electric light journal we propose to insert our Moonlight Schedule as a supplement next year and fight the case out to a finish in advance.

The Design of Induction Coils.

The induction coil is an important piece of electromagnetic apparatus that has been familiar to electricians since Faraday's time. It is also a machine which, in the hands of electrical engineers, has proved most useful for the purposes of power-transmission. There are various ways in which induction coils may be classified. One of these ways is according to the type of core. On this basis of classification, there are three well-known types of induction coil: First, the type employing closed cores of sheet iron, notably the transformer. Such iron cores are therefore laminated in one plane. This type of induction coil is adapted for low-frequency currents. Second, the type employing open cores of iron wire, notably the Röntgen-ray, wireless-telegraph, or gas-igniting spark coil. Such iron cores are laminated in intersecting planes. This type of induction coil is adapted for currents of moderate frequency, lying, say, between a few hundred and a few thousand cycles per second. Third, the type employing non-magnetic cores, of air, glass or oil, notably the Thomson-Tesla coil. This type of induction coil is adapted for currents of high frequency. The modes of construction of the above three types of induction coil differ materially. The first type is built in the largest sizes of all, and is, perhaps, the most generally used. The second type is more complex than the first, and in connection with an interruptor, is far less completely understood. The design of an induction coil of the first type; i. e., a transformer, has already been reduced to an exact science. The design of an induction coil of the second type; i. e., a spark coil, is still more or less empirical, owing to its greater complexity, and to the larger number of imperfectly understood devices contained in it. Recently, however, Prof. F. W. Springer, of the University of Minnesota, has conducted some elaborate experiments which have added very considerably to our knowledge of the spark coil.

The article on "The Design of Induction Coil," appearing on page 1197 of this number, by Messrs. Wm. O. Eddy and Melville Eastham, in relation to the second type of induction coil, gives many facts and suggestions useful to designers, and also to users of these instruments, along lines of practical experience. The writers deplore the crude methods of rating such coils that exist at the present time. It is true that there is hardly any method of rating known except that of spark length. Yet the conditions to which such coils are applied vary so greatly that it would be difficult to establish a rating suitable for general application. The Röntgen-ray coil and the wireless telegraph coil differ so markedly in their requirements, duration of continuous use, output and surroundings, that a method of rating which might serve for the former might be unsuited to a wireless-telegraph coil. Nevertheless, it must be admitted that the greater the degree of precision with which the performance of an induction coil can be measured and specified, the better will be the status of such coils, both from the standpoint of the manufacturer and of the user.

The Physical Meaning of Power Factor.

The power-factor of a circuit is a quantity that came into existence when alternating currents were first investigated. It has been defined as the ratio of the watts to the volt-amperes in a circuit; or of the real power to the apparent power, the apparent power being the product of the indicated effective volts and the indicated effective amperes. It is known that the power-factor of an alternating-current circuit, and particularly of a high-frequency alternating-current circuit, may be even less than five per cent, in extreme cases, while it is often less than seventy-five per cent under practical conditions. It is not generally known, however, that the power factor of a direct-current circuit —that is, of a circuit in which the voltage and current do not reverse, but remain unidirectional—may sometimes be as low as eighty per cent, and might possibly be much lower under experimental conditions. Such conditions arise in the use of rectifiers. It is probable, moreover, that whenever a direct-current dynamo supplies a current to a circuit through a commutator and commutator-brushes, the power-factor of the direct-current circuit is not quite one hundred per cent, owing to the pulsations of voltage and current introduced by the action of the commutator. This pulsating effect is, however, so minute in the case of the ordinary commercial direct-current dynamos that it would take extraordinarily delicate measurements to reveal a difference between the watts and the volt-amperes. For practical purposes it is only the rectifier which decreases the power factor of a direct-current circuit; but theoretically, the power-factor probably only becomes exactly one hundred per cent when a continuous-current circuit is supplied by a voltaic battery, or by a homopolar commutatorless dynamo.

This subject has recently been revived by Prof. Albert F. Ganz in a paper presented before the Franklin Institute, and abstracted in this week's Digest. This paper analyzes the general subject of power factor, and shows that the power factor may be less than unity in an alternating-current circuit without a difference of phase of the voltage and current, the reversals of each occurring simultaneously. In such cases the difference between the volt-amperes and the watts is usually due to periodic changes in the resistance of the circuit. An alternating-current arc is well known to produce a distinct difference between watts and volt-amperes, as measured at the carbons, owing to the fact that the resistance of the arc is lower at stronger than weaker currents. It is evident that there can be no appreciable self-induction in the arc itself, so that there is no reactance in the arc. Moreover, it is known, from observations made with the oscillograph, that the voltage and current at the carbons reverse, or pass through zero, synchronously; so that there is no phase difference between the voltage and current in this sense. The current wave is, however, materially distorted from the outline of the voltage wave, owing to the effect of cyclically varying resistance in the arc.

The Single-Phase Induction Motor.

On page 1202 of this issue is to be found the concluding article of a series by Mr. Alfred Still on the single-phase induction motor. Much attention is given to the discussion of the motor under the starting conditions, on account of the fact that the machine in its simplest form is not self-starting, and special means must always be employed to cause the rotor to accelerate from complete rest. The requirement, as generally stated, is to produce a flux in electrical space quadrature and in electrical time quadrature with the flux due to the current in the main primary winding. More properly stated, what is required is a component of flux in time phase with the rotor current, and oc-

cupying the same position along the air-gap as the conductors conveying the rotor current. Thus a certain flux in space quadrature with the main motor flux will produce the maximum starting torque when it is in time phase with the rotor current, rather than in time quadrature with the main flux. Since, however, in the squirrel-cage type of motor, flux in both time and space quadrature with the main motor flux produces a secondary current which gives an accelerating torque to the rotor by its presence in the main motor field, it follows that the starting requirements are well met when the secondary is subjected to the so-called revolving field. The author discusses in an instructive manner the means that may be employed to produce quadrature flux at starting, and the means required for giving to the rotor current the proper time-phase angle with reference to the adjacent air-gap flux.

Throughout his series of articles Mr. Still has avoided to a large extent any reference to the "revolving field" in the motor, and has chosen to deal with the components of the flux, rather than with the actual resultant flux. The method adopted allows the author to discuss the inter-related phenomena in the simplest possible manner, and to arrive at conclusions sufficiently exact for all practical purposes. It is well in this connection to draw attention to the fact that the method of dealing with imaginary components rather than with the real resultant must, in general, be applied with care. There are conditions under which it is essential to treat components separately, while there are other conditions which necessitate that only the resultant be treated. In dealing with the e.m.f's in the secondary circuit it is convenient to treat each component flux as though the other were not present, but in determining the magnetic energy losses in the secondary core, the most logical method is to recognize the presence of the revolving field, because the calculation of the losses due to the component fluxes may lead to erroneous results. A rigid adherence to the revolving field conception without reference to the effects of the components of the field may result in equally as erroneous conclusions. The only safe method is to consider the existence of both the resultant field and its several components and to ignore neither in favor of the other.

How They Do Things Abroad.

The brief summary of some recent points in European transmission practice which we publish elsewhere deserves more than passing comment. Few Americans realize how much important transmission work has been done and is being done on the Continent, especially in Switzerland and in Italy. These countries were the scenes of some of the very earliest work in this line, and they have been far from letting themselves get behind the times. The map shown of the electric lines in the neighborhood of Milan gives very striking evidence of the amount of important development which has been going on. To be sure, the territory covered is not very large, but there are few or no American cities that could show in the larger suburban territory so complete a network for electrical supply. It shows beautifully thorough utilization of the resources of the district and ought to serve as a stimulus to American enterprise. The debt of the world to Italy in pure and applied science is very considerable, and in few things greater than in electricity. One of the very striking things in this Milan district is the very great number of minor villages taken in by the high-tension network. In one particular the Italian engineers seem to be affected much as in the case of their American confrères, to wit, in the wonderful multiplicity of line voltages. The cause is probably the same in each country—that the networks have represented gradual growth almost since the beginnings of transmission and hence show successive stages in the art. In one particular the range of the Italian voltages is peculiar, since there are not a few lines of 3,000 to 4,000 volts—figures decidedly rare in this country, owing to the lines in which American transformers have been standardized.

In Italy as here the insulator question is foremost. While the foreign insulators are excellent, they do not seem to be immune to the faults that show elsewhere. The effects of long-continued stress have been only too often observed here, and while thorough preliminary testing assuredly has a considerable value, no amount of care will avert some later trouble on the lines. Italian high-tension insulators appear to have been developed in the direction of height rather than diameter, and have more petticoats set at sharper angles than in American insulators. This variation may be in part due to the almost universal use of iron or steel pins in Italian practice, giving better resistance to a pull at the top of a high insulator, and in part to the fact that the simpler American forms should be a little cheaper to build. One bit of Swiss practice should be mentioned in this connection, the winding of the steel pins with tow, liberally treated with insulating material prior to setting in the insulator. Very good results are reported from this very simple device, which gives a well-cushioned support with sufficient flexibility to reduce greatly the severity of mechanical strains. In the matter of general line construction the latticed steel pole early introduced into Italian practice seems to remain a favorite, with spans of moderate though rather considerable length—say in the vicinity of 350 ft.

As regards lightning, misery loves company, and there is a certain reprehensible satisfaction in recording the fact that lightning is as troublesome on foreign lines as on our own. The water-jet lightning arrester seems to be the only device peculiar to Continental practice which has not been freely copied here. It bears a very good reputation, although at 10 to 20 kw per arrester it cannot be very freely used on small systems. It strikes one as a good device for temporary service to supplement other arresters. One could cut in the water jets when a storm became imminent without serious loss, and even a large leakage is many times better than a shut-down. The horn and the shunted-gap arresters bear a good reputation abroad, but troubles come in spite of them. The guard wire which is having rather a boom just now in American construction was tried and turned down for inefficiency in Switzerland nearly twenty years ago—possibly without adequate trial. Its usefulness seems to be very uncertain, however—considerable in some plants, negative in others. As here resonance and surging seem to be important considerations, and with respect to lightning the existence of danger points due to these causes seems to be well established. Such points are given especial protection. The effect in promoting surging of lightning discharges which do not strike the line is a subject to which we think altogether too little attention has been given. The instantaneous application of a very high induced electromotive force to a line carrying high-tension current, even supposing the line is not even struck by a branch flash, initiates all the conditions for a tremendous surge, and the results may be disastrous. It is such abnormal rises of potential that try the insulation and necessitate the use of a higher factor of safety than is generally allowed. It is not the normal voltage that at the present time causes trouble, but the increase of 200 or 300 per cent encountered when something happens on the line. Look out for the surges and the normal voltage will look out for itself.

The German Electrical Industry.

The recent annual reports of the three largest electrical manufacturing companies in Germany show that the industry has made good progress during the past business year. The Allgemeine Electricitäts Company, of Berlin, has again raised its dividend by 1 per cent, distributing 11 per cent, as against 10 last year, and 9 per cent the year before that. The Siemens & Halske Company, of Berlin, pays 10 per cent, as against 9 per cent, and the Schuckert Company, of Nuremberg, which is now operated in connection with Siemens & Halske under the name Siemens-Schuckert Works, pays 5, as against 4 per cent. The gross earnings of the Allgemeine reached $3,347,000, as compared with $2,938,000 last year. The company's earnings have more than doubled in three years.

At the same time these companies published statements regarding the orders on hand which give the most encouraging prospect for the steady employment of their works for many months to come. The Allgemeine announces that of orders filled the third quarter of last year (that is, to the end of September,) and the new business booked to the end of October, amounted to the huge sum of $44,760,000, as compared with $28,570,000 at the same time last year. The Siemens-Schuckert Works say that the volume of old business carried over into the new year, begun August 1, and the new orders coming in since then have both considerably exceeded the figures of last year.

Some details of the Allgemeine report illustrate the development now going on in the German electrical industry. Owing to the great rush of work in the machine shops a further enlargement had to be undertaken. The number of generators, motors and transformers delivered reached 37,424, as against 27,791 last year; the capacity represented by them was 602,241 kw, being a gain of 125,480, or more than 26 per cent. The steam turbine shops turned out 141 turbines with a capacity of 72,475 kw, as compared with 90 machines of 29,550 kw last year. It is a noteworthy fact that the average capacity of the turbines manufactured averaged 514 kw, as against only 328 for the previous year. This company also runs an automobile factory, the increase of business in which is indicated by the fact that the number of workmen rose from 598 to 950 during the business year. The insulated wire and cables turned out at the factory for this specialty registered a gain of nearly $2,500,000, and the copper consumed rose to 16,700 tons, as against 14,800 in 1904-5. The manufacture of the Nernst lamp was restricted somewhat by a great strike and through the removal into new shops; nevertheless, the total of lamps and burners hitherto turned out now reaches 7,500,000. The number of employes in the Nernst shop is 1,160, as compared with 695 last year.

One of the chief fields of work for the German electrical companies for the past three or four years has been putting in power plants for coal mines and iron manufacturing establishments. The Allgemeine's report says that its installation department was occupied last year chiefly by these two industries. "The development of electrical transmission," says the report, "comes to the aid of the iron industry through the utilization of waste gases for power, and while the gas engine seems to predominate the steam turbine is creating a rapid opening for itself at mines." The report mentions the fact that the company has recently put into operation the first electrical plant for driving reversible rollers. This mill is situated in Austrian Silesia, and it is the first one of the kind in the world, but the Allgemeine has several others in course of construction. At the Silesian mill the generators are driven by steam turbines. While many iron companies in Germany have put in continuous rollers driven by electricity, they were checked at the blooming mill; only the old-fashioned steam engine was thought adapted to do this heavy work, as it required repeated reversing of the rollers. As it is now demonstrated that electricity can serve reversing rollers successfully, iron manufacturers can electrify their plants throughout. That they will have great inducements for doing so is evident from the experience of the Silesian mill referred to, where it is reported that a 10 per cent saving of expense has been attained. This would seem to open up remarkable prospects for the electrical industry of the world; and the revolution of the iron industry through electrical power seems only a question of time.

The steady increase in the consumption of electricity in Berlin is again shown by the annual report of the Berlin Electrical Works, a concern closely allied with the Allgemeine, and having a practical monopoly of the sale of electricity in Berlin and some of its suburbs. This company reports a consumption of above 128,000,000 kw-hours for the past year, which denotes a gain of 16,500,000, or nearly 15 per cent. Although the company had net earnings of $1,243,000, as compared with $1,110,000 last year, it distributed the same dividend, namely 10 per cent, as for 1904-5. It has now reached its productive capacity with its existing generating stations, and proposes to erect an additional station with a capacity of 15,000 hp. The company now has a capital, including obligations, of $19,000,000, and it is probable that it will have to be increased soon to pay for new construction.

In other directions, too, the need of new capital in the electrical industry has been observed. The Bergmann Electrical Works has just issued $952,000 of new capital, giving it a total of $3,330,000. The company estimates that its turnover for the calendar year will reach $3,810,000, as against $3,100,000 last year. It pays a dividend of 18 per cent a year, being the highest dividend paid by any German electrical company. It manufactures certain patented electrical goods and has just been adding new lines. It has not been long since the company enlarged its shops, and already it announces that these are not big enough to enable it to fill its orders on time.

The Schuckert Company is also about to raise $1,900,000 new capital in order to strengthen its financial annex, the Continental Company for Electrical Undertakings. The latter concern got itself into difficulties during the great boom of seven years ago by a too rash investment of its resources in electrical plants in places where they could not pay, and its stockholders have not had a dividend since them. It is now calling for payments upon its stock equivalent to $2,650,000, with which to get rid of its deficit and make necessary write-offs on bad securities held.

The Society for Underground and Electrical Railways, which opened an electrical road, partly underground and partly elevated, in Berlin about five years ago, is about to issue $2,400,000 new stock for the purpose of building an underground extension through the heart of the city from the Potsdam Platz to the Spittal Markt. It is also carrying its underground line in Charlottenburg as far as West End, where a connection for Spandau will be made later. The line to the Spittal Markt will also be extended later through the city to the Alexander Platz and then outward to the city limits. The city of Berlin itself has long been engaged upon a plan to build a north-and-south subway through the heart of the city, and it now seems probable that the work may be begun within a year.

A still more important issue of new stock was made several months ago by the German Oversea Electrical Company, a concern which has been operating the electrical street car lines in Buenos Ayres and Santiago, Chili. It has undertaken a great extension of its business by acquiring the street railways in Montevideo and Valparaiso, and a great new power station is to be erected at Buenos Ayres. In carrying out these extensions the capital has been doubled by raising it to $8,570,000.

The subject of electric traction on broad-gauge roads is attracting increasing attention in Germany; but this is confined to short distances only and to specific purposes, like tunnels and suburban roads. Such a road has been in operation for more than three years between Berlin and the suburban town Gross-Lichterfelde, and it has had to increase its rolling stock steadily. Hamburg is building such a road to Blankenese on the lower Elbe, in connection with a far-reaching reform of its existing surface roads in the city. The Allgemeine and the Siemens-Schuckert companies are building the roads jointly upon a $9,500,000 contract, not including equipment and generating plant. The standard-gauge road will have a total length of almost 17 miles. The first section of it will be put into operation within a fortnight, and the rest in the course of the winter. Siemens-Schuckert is building the power station, which is equipped with unusually heavy generators run by steam turbines.

Light and Illumination.

At the December meeting of the New York Section of the Illuminating Engineering Society, Dr. C. P. Steinmetz delivered an address on "Light and Illumination," which, although treating of phenomena closely related to the physical facts discussed in his recent paper before the American Institute of Electrical Engineers, yet differed therefrom in that the treatment employed allowed the speaker to arrive at conclusions particularly interesting and valuable to the illuminating engineer, who is concerned with the utilization of light, while the Institute paper was intended for the electrical engineer, who deals with the production of light.

In his opening remarks Dr. Steinmetz drew attention to the fact that light is not a quantity which can be treated by ordinary engineering methods, because it relates to physiology rather than to physics. It makes itself manifest as an excitation of the retina. It is found to consist of transverse vibrations in the ether traveling at about 188,000 miles per second, and differs essentially from sound, which is transmitted as a longitudinal vibration through air or some other medium. The transverse vibrations can be obtained by heating a body to certain temperatures under which conditions vibrations of all kinds of frequencies are made manifest. The vibrations recorded as light possess frequencies of a limited range corresponding approximately to one octave, while a heated body gives off vibrations throughout several octaves. The vibrations of extremely high frequency are frequently referred to as electro-magnetic waves, while those of frequencies much lower than light are referred to as heat waves. There is no sharp distinction between the characteristics of waves of different frequencies. The waves possessing frequencies immediately higher than light rays are sometimes referred to as chemical rays. All rays, however, are capable of producing chemical effects, some chemicals being sensitive to certain rays and other chemicals to certain other rays. The chemical breaking up of a molecule is due perhaps to a phenomenon similar to resonance. When the frequency is correct, according to the chemical molecule, the atoms are torn apart. This phenomenon is more frequently observed at the violet end of the spectrum corresponding to the high frequencies, than to the red end corresponding to the low frequencies. Chemical activity also takes place at the red end of the spectrum, and this last phenomenon is found most commonly in plant life.

As stated above, light, as a quantity, cannot be directly measured. It is possible, however, to determine what portion of certain composite vibrations, as, for example, those obtained from a heated body, lie within the visible range by interposing between the source of light and the instrument which is used to measure the effect of light some medium which is opaque to rays which are above and below the visible rays. Glass and water are frequently used to absorb part of the rays outside of the visible range, while the bolometer is used for determining the heat effect when all of the rays are employed and when only the visible rays are allowed to fall upon the instrument. It might seem that the bolometer could thus be used to determine the efficiency of the source of light. It must be remembered, however, that the flow of energy of the rays is not constant throughout the spectrum, but is a function of the wave length. It is very small or zero at each end and it increases to a certain maximum at the middle, so that a determination of the heating effect cannot be used as a measure of the effect produced on the retina. The physiological effect of the power of different colors cannot be directly compared and cannot be photometered. The effects can, however, be indirectly compared by observing the distance from each source at which the illuminations obtained from the two are equal. Experiments have shown that green light is conveyed with less diminution than is red light. It is found also that different persons differ in sensibility with reference to the different rays. The discrepancies obtained by different observers are not prominent, however.

Formerly all the electric lighting was obtained by incandescence, and it was found that the higher the temperature the more efficient was the transformation of power into light on account of the fact that at such temperature the larger portion of the rays produced were within the visible range. In the carbon filament lamp the temperature is limited, not only by the maximum instantaneous rupturing value which corresponds to the boiling point of carbon, but by a lower value which corresponds to the evaporation point of the filament, at which the filament disintegrates with such rapidity that the life of the lamp is materially decreased. The highest temperature which can be employed in any carbon lamp is found in the arc lamp, which is always operated at the boiling point of carbon. Incandescent filament lamps can be given a high illuminating efficiency by using materials which do not evaporate sensibly at relatively high temperatures, although the actual boiling point may be even lower than that of carbon. Such materials are usually metallic in nature, the ones now commercially employed being tantalum, osmium and tungsten. The above mentioned materials at any certain temperature give forth rays at almost all frequencies, and the proportion of rays within the visible spectrum varies largely with the temperature of operation. It is possible to obtain an illuminating efficiency even higher than that given by the above mentioned metals by employing certain other materials which at certain temperatures give forth rays within a limited range. Such selective radiation is found in the material of the Welsbach mantle. Selective radiation is also a prominent characteristic of gases in which the frequency of vibration is practically independent of the temperature and depends entirely upon the material of the gas. Thus mercury vapor gives a light which is frequently spoken of as green, although the actual rays found in the light vary with the pressure of the gas. Calcium is another material which shows selective radiation, and such radiation is the principal source of the high efficiency of certain impregnated carbons.

The illuminating engineer is concerned more particularly with securing illumination rather than light. The problem which confronts him is one dealing with effects rather than causes. In each specific problem it is ordinarily desirable to have both general and concentrated illumination. Thus, in an office one wishes to have the whole room illuminated at a low density and the desk brilliantly lighted. Illumination may be either direct or indirect. Although, with reference to the light rays obtained, the direct is much the more efficient, yet for almost all purposes the indirect gives the better illuminating effect. It is particularly desirable to have uniformity of illumination rather than concentration of light for the general lighting. For the concentrated lighting it is best to use a single lamp with reflectors which cause the rays to pass in the desired direction. In any event, the lamps should be placed entirely out of the field of vision. The prime requisite is to have the light fall upon the object which one wishes to see without too pronounced shadows and without an excessive amount of light from other sources reaching the retina. The amount of light which reaches the retina depends upon the opening of the pupil, and the contraction of the pupil depends largely upon the heat energy contained in the rays which strike the eye. The eye is so constructed that by variation in the opening of the pupil the amount of light which reaches the retina may not be largely varied even when the density of illumination changes in the ratio of 1 to 1,000. It is the task of the illuminating engineer to so place the lamps that the heat energy of the rays which reach the eye will allow the pupil to expand to such an extent that the light rays which come from the body that is to be viewed will be of just the right density when they reach the retina. Thus all lamps should be removed from the line of vision and all glare should be carefully avoided.

The discussion was opened by the Chairman of the New York Section, Mr. A. E. Forstall, who described the chemical reactions taking place in the Bunsen flame and explained the facts to which its non-luminosity may be attributed. He emphasized the importance of so shading the lamps as to keep all bright light out of the eyes, and remarked that it is the light which reaches the eye from the object viewed that is of value from the illuminating engineering standpoint. Mr. Preston S. Millar reported the results of some comparisons made with green and red light by means of photometers. When the illuminations from the two sources were so adjusted as to seem to be equal at 10 feet, it was found that at 50 feet the illuminations differed by from 30 per cent to zero, according to the photometer used, the flicker photo-

meter indicating that no difference existed. It is the intention to continue the tests by comparing the light obtained from the two sources by means of the "reading distance."

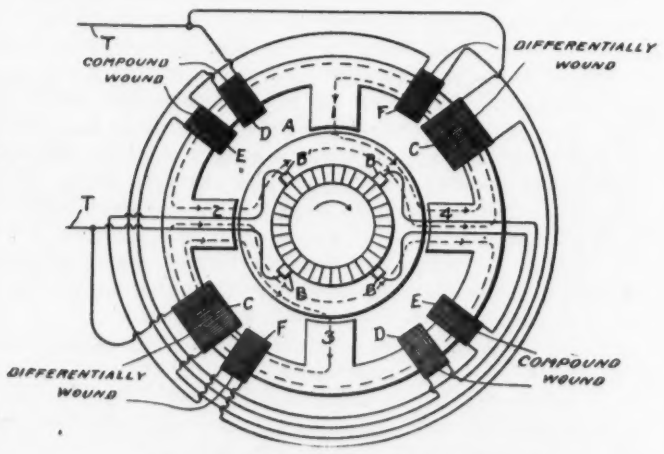
Mr. G. V. Williams outlined the requirements concerning the selection of the lighting units for various rooms, and stated that the selection would be determined largely by the local requirements. Mr. V. R. Lansingh remarked that even in desk lighting shadows are objectionable, but they cannot be entirely eliminated. Experiments have shown that a variation of 20 per cent in the density of light may be permitted. In many cases extreme intensity is even more objectionable than shadows.

Mr. Paul McJunkin discussed the variation in penetrating powers of the red and green rays obtained from the various lamps, and expressed the hope that additional experimental evidence would be obtained concerning the penetration. In closing the discussion Dr. Steinmetz stated that the remarkable fact that the flicker photometer seems to indicate that the red and green rays have equal penetrating powers, while other photometers show that green is much more penetrating than red, does not prove that the flicker photometer is the proper one to use when comparing these rays. As a matter of fact, the best way for comparing rays of different colors is the "reading distance" method, which shows conclusively that the green rays are much more penetrating than the red.

Constant-Current Generator.

The accompanying illustration shows a type of constant-current generator for which a patent was granted to Mr. Maurice Milch on November 6. The machine illustrated has four projecting poles, but is magnetically equivalent to a two-pole machine and the armature is provided with a two-pole winding.

The brushes, *B B*, which supply the external circuit, are placed in the usual manner at or near the neutral points with respect to the poles produced by the coils, *C C*. The coils, *C C*, are shown connected in shunt to the machine terminals, *T T*. The current flowing through the brushes, *B B*, tends to produce a magnetization of the machine at right angles to the magnetization produced by the shunt-coils, *C C*—that is, it tends to make the poles, 1 and 4, of one polarity, and 2 and 3 of the other polarity. This tendency is opposed and overwhelmed by a set of coils, *D D*,, which are connected in series with the brushes, *B B*, and with the external circuit. These coils, overpowering the magnetizing action of the armature-current between brushes, *B B*, produce a magnetization proportional to the current in the external circuit at right angles to that produced by the shunt-coils, *C C*. This cross-magnetization induces an electromotive force in the armature



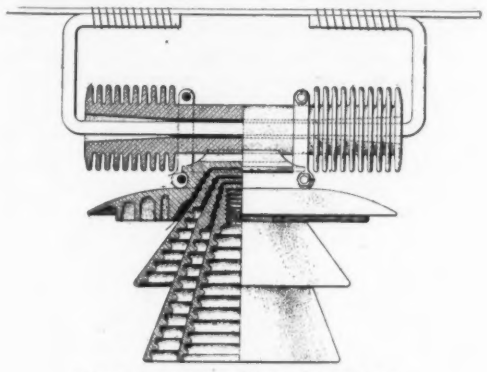
MILCH CONSTANT CURRENT GENERATOR.

which is a maximum at the points displayed 90 deg. from the brushes, *B B*. At these points a second set of brushes, *B' B'*, is placed, and in series with these brushes are connected two sets of coils, *E E*, and *F F*. The coils, *E E*, assist the coils, *D D*, in producing the cross-magnetization of the machine, while the coils, *F F*, oppose the magnetizing effect of the mains coils, *C C*.

The operation is then as follows: A slight increase in the current in the external circuit, due either to an increase of speed of the machine or a decrease of resistance in the external circuit, increases the cross-magnetizing effect of the coils, *D D*, and consequently increases the potential between the brushes, *B' B'*. This increased potential increases the current in the coils, *E E*, which further increases the potential across the brushes, *B' B'*, and the increase of current in the coils, *F F*, reduces the main-field magnetization of the machine. The current output of the machine is thus kept substantially constant over a wide variation of speed or with wide variations of resistance in the external circuit.

High-Potential Line Insulator.

The insulator shown in the accompanying illustration was the subject of a patent issued December 11 to Prof. F. G. Baum. The insulator has been designed for very high voltages, and is arranged to operate effectively in rainy weather and not to deteriorate from accumulation of dust upon its surface. The line wire is supported by a tubular insulator, having ribs adapted to be

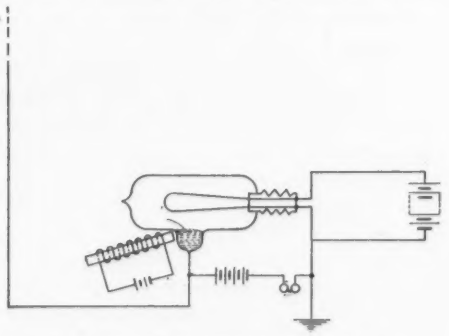


BAUM HIGH-TENSION INSULATOR.

washed by the rains, which is mounted on an insulator having numerous petticoats, each of which has its inner surface corrugated so as to provide a greater insulating surface. The ribs of the tubular insulator being washed by the rains are always absolutely clean, and secure perfect insulation in dry weather. In wet weather the interior surfaces of the petticoats are in condition to effectively insulate the line conductor.

Mercury-Vapor Wireless Detector.

A patent issued December 4 to Dr. Lee De Forest covers the wireless telegraph detector illustrated herewith. The active portion of the detector consists of two electrodes separated by heated mercury vapor. One electrode is formed by mercury and the other by an incandescent lamp filament, which is heated by an external battery. In order to render the detector selectively responsive, means are provided for creating a stationary magnetic field as a tuning device, the frequency for which the



DE FOREST WIRELESS DETECTOR.

detector is most sensitive depending upon the strength of the field. It is stated that the magnetic field retards the movements of the conducting ions in the gaseous medium, and if the ions are moving under the influence of a rapidly-vibrating electromagnetic impulse the resultant effect from the magnetic field will be a function of the frequency or rate of vibration of the impulse, so that for a given field the resultant effect will be a maximum for a given frequency.

Electric Cooking Cost Data.

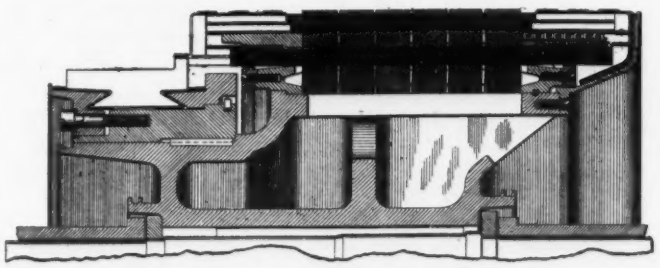
The current issue of *Clarkson's Bulletin* prints a graduating thesis by Miss Charlotte Degell Seaver, B. S., which discusses the economics of electric heating. From this the following table is extracted:

The heating efficiency of one of the stove plates used was determined by raising 2 lbs. of water from 42° to 212° Fahr. In one case the efficiency was 57.8 per cent., and in another 87 per cent. In baking, the current was turned on from twenty to thirty minutes before the articles to be baked were placed in the oven, so as to allow for thorough heating. The current was turned off ten minutes before the baking was done, as the oven would remain hot enough to complete the operation. It was possible to hold the hand outside, even when the oven had its highest heat, without a feeling of discomfort. The broiler was used in much the same way, with the exception that the current was only turned on from five to ten minutes before being ready to cook, and turned off five minutes before the article was entirely done; see experiment III.

Apparatus.....	Broiler	Water heater	Oven	Oven	Oven. Stove. Broiler.	Oven. Stove. Broiler. Water-heater.	Oven. Stove. Broiler. Water-heater.
Operation	Broiling	Heating water	Baking	Baking	Getting breakfast for six.	Getting luncheon for six.	Getting dinner for six.
Food	Beek steak		4 mince pies	Beef roast	Cereal. Muffins. Broiled steak. Coffee.	Cream of celery soup. Croutons. Lamb chops. Potato puffs. Baking-powder biscuits. Salad dressing. Cheese straws. Peach cobbler. Cocoa.	Tomato soup. Toasted crackers. Roast chicken with dressing. Giblet gravy. Mashed potatoes. Scalloped cabbage with cheese. Porterhouse rolls. Grape ice. Almond macaroons. Coffee.
Weight	1.5 lb.	2 lb. from 42 to 212° Fahr.		6 lb.			
Time required, mins:							
1°, from cold to effective cooking temp.....	10		30	20			
2°, for operation specified	10		35	1 hr. 35 m.			
3°, total.....	20		1 hr. 25 m.	1 hr. 55 m.	1 hr. 45 m.	1 hr. 50 m.	2 hrs. 30 m.
Energy required, kw-hr.:							
1°, from cold to effective cooking temp.....	0.122		.09	0.35			
2°, for operation specified	0.151	0.1271	0.7	0.96			
3°, total kw-hrs..	0.273		1.60	1.31	2.7	3.6	6.25
Cost, based on 4 cents per kw-hr..	$0.01092	$0.005	$0.064	$0.0524	$0.108	$0.144	$0.25

Resistance Leads for Commutator Motors.

When high-resistance leads are connected between the armature and the commutator bars of an alternating-current motor, the leads are frequently located in the bottom of the slots which contain the armature winding, and each resistance conductor is doubled back on itself in order to eliminate inductive effects.

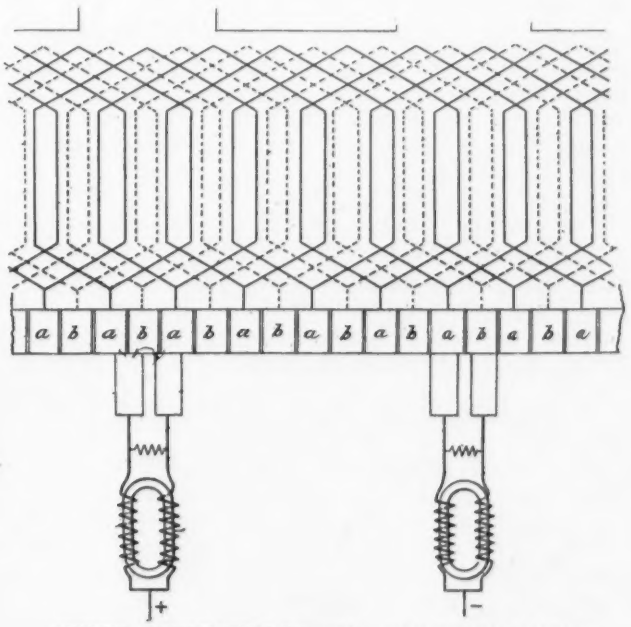


LAMME HIGH RESISTANCE LEADS.

In order to avoid enlargement of the core-slots beyond what is demanded for proper electrical proportions and to also avoid transference of heat from the resistance leads to the armature coils. Mr. B. G. Lamme, according to a patent issued December 11, would provide independent slots in the armature core for the resistance-leads, as shown in the accompanying illustration. It is stated that the most advantageous distribution of the resistance leads will be obtained when the number of slots for the leads bears a definite ratio to the number of slots for the armature winding, and the six claims of the patent relate to a value which is the inverse ratio of the number of conductors in the resistance-lead slots to the number in the armature-coil slots.

Double-Wound Alternating-Current Commutating Motor.

A method of employing external impedance for preventing sparking in alternating-current commutator motors is described in a patent issued December 4 to Mr. S. S. Seyfert. The accompanying illustration shows a development of the armature commutator and two brush sets, of a four-pole model. The armature is provided with two windings, one being shown in full lines and the other being shown in dotted lines. The two windings overlap each other, but are otherwise independent of each other.



SEYFERT ALTERNATING-CURRENT COMMUTATOR MOTOR.

Each coil of each winding is connected with a commutator bar, the bars of the two windings being placed alternately. Positive brushes and negative brushes are arranged in pairs circumferentially of the commutator and each brush in such direction is of a width not greater than the width of the commutator bars, so that a single brush can never connect two commutator bars of a common winding. Since, however, two commutator bars connected to a single armature coil can be touched by two brushes of the same holder, choke coils are placed in circuit between the

brushes to prevent the flow of an excessive current in this circuit. The choke coils are so arranged that they are mutually non-inductive to the main line current. In the position of the armature just described, as illustrated to the left in the accompanying diagram, there is formed a direct short-circuit from a commutator bar of one winding up through the brush, down through a bar of the other winding up through the second brush and down to a second commutator bar of the former armature winding. In order to prevent the sparking due to the interruption of the current flowing through the above-mentioned short-circuit, the inventor connects a non-inductive resistance between the leads from the two brushes at each commutating point.

Co-operative Electrical Development Association.

An important meeting of the Co-operative Electrical Development Association was held in New York City on December 13, under the chairmanship of Mr. W. M. McFarland, when Mr. J. Robert Crouse presented a paper dealing with the results secured since last March.

The chair appointed the following committees: Committee on Constitution and By-laws—Messrs. E. E. Jackson, chairman; A. D. Page, General Electric Company; Walter Cary, Sawyer-Man Electric Company; F. J. Newbury, John A. Roebling's Sons Company; W. W. Freeman, Edison Electric Illuminating Company, of Brooklyn.

Committee on Commercial Programme—Messrs. F. S. Terry, chairman; W. C. Bryant, Bryant Electric Company; R. S. Hale, Edison Electric Illuminating Company; A. L. Doremus, Crocker-Wheeler Company; E. W. Gillmer, Peerless Electric Company; F. Bissell, the F. Bissell Company.

Committee on Membership and Assessments—Messrs. J. S. Anthony, chairman; Walter Cary, Westinghouse Electric & Manufacturing Company; W. W. Freeman, Edison Electric Illuminating Company, of Brooklyn; Charles B. Price, Pettingell-Andrews Company; James R. Strong, president National Electrical Contractors' Association. The meeting closed with a banquet in the evening, presided over by Mr. Anthony.

CURRENT NEWS AND NOTES.

A PECULIAR SYSTEM OF RATES.—A very peculiar system of charging has been used to a limited extent at Toledo, Ohio. The plan is to charge the customer 5 cents per kw-hour for all energy used up to a certain figure, which figure is named by the customer. For all over the specified figure the rate is 10 cents per kw-hour.

STORMS IN ITALY.—A dispatch from Rome, dated December 15, states that terrific storms of snow, wind and torrential rains have caused serious damage to all the Italian telegraph lines. Throughout the morning of that day Rome was entirely isolated. It would be interesting to know how far the wireless system came to the rescue.

FUEL LACKING IN NORTHWEST.—Reports from North Dakota, Northern Minnesota and the northwest region generally indicate a sore lack of coal, owing to short supply, heavy demand, snow blockades and scarcity of cars. Grain, furniture and fences are being used for fuel. Schools have been closed at various points and lighting and heating plants have suspended operation. Efforts are now making for prompt relief of a situation rapidly becoming very desperate.

GAS ON RAILROADS.—It would seem that gas lighting systems may have to go on electrified steam roads. The Pintsch gas system for the lighting of the cars of the New York Central and the New York, New Haven & Hartford Railroads was put out of commission at noon on December 17 in the New York Central terminal yards by an explosion which was caused by a third-rail spark, according to one story, and by a carelessly dropped match, according to the railroad officials. The fire looked very dangerous for a time, as it was difficult for fire engines to get within range.

SAVING A LIGHTSHIP.—An unusual but striking example of the use of storage batteries in an emergency is found in the story connected with the sinking of Lightship No. 58, stationed off Nantucket Shoals, Mass. This lightship, it may be recalled, was blown from its moorings during a severe gale, and the crew would undoubtedly have perished but for wireless messages, which they sent out and which enabled the lighthouse tender *Azalea* to reach them before the ship sank. It has since become known that the generating machinery was useless, due to a leak in the vessel extinguishing the fires, so that the power to operate the signals was secured entirely from a battery of "Chloride" accumulators. At the time the last message was sent, one-half of the battery was submerged.

SUBWAY FOR PITTSBURG.—Advices from Pittsburg state that the Pittsburg Subway Company chartered to build a subway between downtown Pittsburg and East Liberty, the residence section, and on to Wilkinsburg, through the densest portion of the population, is pushing its plans. President J. D. Callery, of the Pittsburg Railways Company, and vice-president of the Philadelphia company, says: "We considered the matter of building such a subway to relieve the congestion of the surface lines, but found that it was not feasible. The topography of the hills and valleys, etc., is so different from New York that a parallel cannot be drawn, and the subway could not be supplied with traffic more than one-fourth of a mile from the stations. It would have to have feeders, as Pittsburg, unlike New York, which is a long stretch, spreads out in the form of a wide open fan. Without feeders I do not see how the proposed subway can be financed. It will cost at least $15,000,000."

TO SUPPRESS NOISES.—Mrs. Isaac L. Rice, who has recently been so successful in checking unnecessary whistling and tooting on the Harlem River, has perfected an organization to be known as the Society for the Suppression of Unnecessary Noises. It is already turning its attention to trolley cars in front of hospitals, locomotive bells, automobile horns, etc., as well as early morning delivery wagons. There is a very strong advisory board. Constituting the society's board of directors are Dr. Armstrong, superintendent of the Bellevue, Fordham, Gouverneur and Harlem Hospitals; Dr. Hornby, superintendent of Flower Hospital; Dr. Mabon, superintendent of the Manhattan State Insane Asylum; Dr. Goldwater, superintendent of Mount Sinai Hospital; Dr. Clover, superintendent of St. Luke's Hospital; Dr. Kartum, superintendent of the German Hospital; Mr. Lamb, superintendent of the City Hospital; Mr. Townley, superintendent of the J. Hood Wright Hospital; Dr. Ryder, resident physician of Sloane Maternity Hospital; Dr. Gregory, resident alienist at Bellevue; John Talbot Smith, president of the Catholic Summer School of America; Prof. Shotwell, of Columbia University; T. C. Martin, editor Electrical World; Francis Hamilton, solicitor to the Collector of the Port; Dr. John H. Girdner and John J. Rooney.

NEW CREEDS.—With regard to a new catechism printed in the daily papers this week, the New York *Evening Post* comments adversely as follows on the attempt to reconcile radio-activity with revelation: "Sir Oliver Lodge's new religious scientific *Credo,* as given in the New York *Sun,* is not more successful than the average attempted solution of that hoary problem, 'the reconciliation of science and faith.' The principal of Birmingham University is now the most prominent exponent of orthodoxy for scientists as opposed to the younger British school of investigators. They have shown a weakness for framing bold interpretations of the universe on the basis of startling but insufficiently tested discoveries. Witness the recent campaign of the radium and radiobe enthusiasts, who brought down on their heads the just wrath of cautious Lord Kelvin. But there is this to be said in favor of the younger school: that their views present at least a consistency which we do not find in Sir Oliver Lodge's catechism for teachers. That document breathes much of the spirit of the eighteenth century deists in its acceptance of the great existing truths of faith and morality as cognizable through reason, but it is in parts also mystic, pantheistic, pan-psychist and Buddhist, with a touch even of Christian science in its definition of evil as that which is 'akin to disease, ugliness and misery.'"

LIGHTING MAIL CARS.—Senator La Follette has introduced a joint resolution in the United States Senate requiring all railroads within one year to equip mail cars with electricity instead of gas or oil or other inflammable and explosive lighting materials.

MAGNETITE LAMPS.—A number of installations of magnetite arc lamps for street lighting have been contracted for in the Middle West recently. At Kansas City 250 are in operation. At Paris, Ill., 125 are contracted for; at Mattoon, Ill., 125, and at Pekin, Ill., 140.

INTERNATIONAL ELECTROTECHNICAL COMMISSION.—The commission provided for last June at a meeting in London of representatives of national electrical engineering bodies held to discuss international electrical standardization, has established a central office at 28 Victoria Street, Westminster, London. Mr. C. C. Maistre is acting secretary of the commission.

NEW SUBWAY IN LONDON.—A cable dispatch from London of December 12 says: "The railway between Brompton and Piccadilly, the latest and longest underground electric tube, was formally opened to-day. It is nine miles long and has twenty-one stations. By means of interchange at stations it is now possible to travel by electric road, underground, the whole length and breadth of London."

FUEL TESTS WITH ILLINOIS COALS.—Professors L. P. Breckenridge, S. W. Parr and H. B. Dirks are the authors of a very valuable bulletin of the University of Illinois, Vol. III, No. 22, on "Fuel Tests with Illinois Coals." This bulletin gives the results of tests and analyses of a large number of coals mined in Illinois and also information on the methods of testing these coals, of value to engineers and students. The bulletin is one which will be kept as a work of reference by all those interested in steam fuels within the district served by Illinois coals, as well as by many others.

FALL OF BIG TOWER.—Cable dispatches from England of December 6, describing a big gale there, report the destruction of the wireless telegraph tower at Machrihanish Bay, Scotland, which was 450 ft. high and weighed 2,000 tons. This tower was erected for wireless communication with America. It collapsed and crushed to the ground. Fortunately it fell clear of the adjoining buildings, and nobody was injured. So far there has been a remarkable freedom from casualties of this kind, considering the light construction of these lofty towers on exposed promontories and sea coasts.

CABLE TO MADAGASCAR.—United States Consul William H. Hunt, of Tamatave, Madagascar, advises that the newly laid cables between Madagascar, Reunion and Mauritius are completed and in connection with the world's cables. The rates for cablegrams between Europe, or in transit thereto and therefrom, and Madagascar and Reunion by the Dakar-Cape Town-Mauritius cable, or via Malta and Aden, are 65.137 cents per word, or 26½ cents for press cablegrams. The term "Europe" includes Algeria, Tunis, Tangier and Tripoli. The interchange of cablegrams between Madagascar, Reunion. Mauritius and Mozambique costs 20 to 40 cents a word.

CALLING TIME FOR A CITY.—A whistle that can be heard normally at ten miles, and at twenty with a strong wind, has been installed by the East St. Louis and Suburban Electric Railway Company at the belt power house, where the company's machine shops and car barns are located. The greatest modern siren comprises three whistles. The largest is almost six feet in height and nearly as big around as a man. On each side of the main one is a smaller whistle. This big triple whistler is connected with an electric clock, regulated by the Government standard time sent out from Washington on the dropping of a ball at exactly noon each day. The electric clock with the whistle is guaranteed not to vary five seconds in time a year, and the clock's record to date is satisfactory.

DOUBLE-DECK SUBWAY.—At a meeting of the New York Rapid Transit Commission last week a communication was received from the Board of Estimate recommending that in advertising bids for subways they be advertised in two ways, one calling for construction alone and the other calling for construction, equipment and operation. It was resolved to follow this suggestion in the future. On the recommendation of the chief engineer it was resolved to construct the Lexington Avenue subway on the double-decked plan. In this way the local tracks would be near the street surface and the express tracks directly underneath them. This plan is necessitated by the narrowness of Lexington Avenue. The express tracks will be about 35 ft. below the surface and all the express stations will be provided with escalators.

THE PATENT SYSTEM.—Mr. F. P. Fish, formerly one of the most eminent and successful members of the patent bar and now president of the American Telephone & Telegraph Company, has lately found time for the public discussion of economic and sociological subjects. He is now to make an address before the American Society of Mechanical Engineers on "The Ethics of the Secret Process versus the Patent System." This will be delivered in the main auditorium of the new Engineering Societies' Building, on January 8, and will be the first occasion of using that splendid hall. Mr. Fish will treat on the relative rights of a man who elects to manufacture under a patent, in distinction to one who manufactures without a patent, maintaining his process a "trade secret." The topic is broad in its vital interest to engineering, and we understand that a general invitation is extended to all professionally interested.

CHICAGO ELECTRICAL SHOW.—Electrical meetings and other attractions are gradually centering themselves about the Chicago Electrical Show to be held at the Coliseum, Jan. 14 to 26. The Northwestern Electrical Association convention will be held there Jan. 16 to 18. The Chicago Section of the Illuminating Engineering Society will hold its meeting the evening of January 17. Sons of Jove Day will be Tuesday, January 22; Electrical Salesmen Association Day, Thursday, January 24. Thirty thousand square feet of space have been sold for general exhibits on the main floor of the Coliseum, and only four spaces remain unsold. The Coliseum Annex will be divided into four small theatres for an electric midway. Demonstrations with static apparatus and high and low-frequency current will be given in one of these. In another will be a new electrical and mechanical creation entitled "Aurora Borealis," invented and arranged by Edgar Healey, of Chicago.

BEAUTIFYING NIAGARA.—In regard to the electrification of Niagara Falls, the Buffalo *Express* points out one or two facts that have been overlooked and says: "The president of the American Civic Association is not the only person who has asserted that the Canadian authorities have cut off 500 ft. of the Horseshoe Falls in order to accommodate the power companies, and it is, therefore, of considerable importance to have the statement refuted so clearly as is done in the letter written by the chairman of the Queen Victoria Park Commission to the Canadian Niagara Power Company. This letter and certain extracts from an old report of the commission, were presented to Secretary Taft. The chairman of the park commission explains that, owing to the falling away of rock at the center or apex of the Horseshoe Falls, the channel has deepened at that point and thus drawn water from the Canadian shore. This change exposed the river bed and made the shore unsightly, in the opinion of the park commission. In order to improve these conditions, the commissioners had the power companies dump along the shore the rock which they took from their tunnels. Any one who has visited the Canadian side of the falls recently and understands the scheme for improvement knows that Queen Victoria Park will be much more beautiful than ever when the work is finished. The only serious loss is that of the rushing waters around the Dufferin Islands, but even here it is a matter of taste. These are many who would prefer the swift stream that formerly flowed around these islands to the conditions that will exist when the present plans are carried out. There are probably just as many, however, who will be better pleased with the change."

PREMONITORY FIRE ALARM.—The city of Bridgeport, Conn., has a system whereby a fire brigade leaving the fire house closes a circuit on gongs along the street, so that an alarm is given to persons on the street two minutes before the engine comes dashing along. Hence danger and damage are avoided. It is proposed to try the same system in New York, where serious accidents to people and the fire brigades often occur, on account of the absence of a warning.

CENTRAL STATION LITERATURE.—The December bulletins of many of the central station companies this year are works of art, and are calculated to do a good deal of effective work. Such examples as those of the New York Edison, Boston Edison, Brooklyn Edison, Chicago Edison, Denver Gas & Electric, Cleveland Illuminating Company and New Jersey Public Service Corporation may be specified. Particularly happy is the insert of the New York Edison, being a reduction of its big poster and poem, showing Nosworthy's charming sketch of Tommy afraid on the stairs with a dim flickering candle and telling how brave he became when the bright electric light was installed. It is an excellent piece of work.

LIGHTING AT EASTON.—It is stated that the effort to improve the municipal lighting plant in Easton by the installation of a large number of new lamps has failed, and the citizens are now following the lead of Mayor F. A. March in demanding that the plant be abandoned and light be procured from a private corporation. So great is the agitation that leading citizens are being urged to become candidates for election to the city council in February on anti-municipal ownership platforms, and several are expected to do this. It appears that $50,000 has been wasted in the last ten years on the plant and that at no time, even in the very best conditions, was it any more than a very expensive toy to the city.

WIRELESS TELEPHONY.—A cable dispatch from Berlin of December 14 says: "The German Society of Wireless Telegraphy has succeeded in holding wireless telephonic communication between Berlin and Nauen, twenty-four miles away. Prof. Slaby, in an interview, described the experiment as eminently successful.' The conversation was carried on partly by Herr Von Sydow, Under Secretary of the State Postal Department, who received perfectly intelligible repetitions to his questions. Prof. Slaby says the problem of wireless telephony is solved, but that the limit of distance is not yet known. He sees no reason to set any limit, and believes that the time is coming when a man will be able to speak wirelessly with a friend in any part of the world. The method employed to-day consists of the use of the microphone in connection with the ordinary wireless telegraphy apparatus."

A. A. A. S.—A large gathering is expected in New York City for the annual meeting of the American Association for the Advancement of Science, which will be held at Columbia University from December 27 to January 2. The members of a number of other scientific societies have been invited. At the first meeting, on Thursday, December 27, the association will be welcomed in Earl Hall by President Nicholas M. Butler, and in the evening, in Horace Mann Hall, the retiring president, Dr. C. M. Woodward, of St. Louis, will deliver his address upon "The Science of Education." It will be followed by a reception by the trustees of Columbia and an informal smoker in the Faculty Club. The meetings of the sections for the reading and discussion of papers will continue every day until Tuesday. On Saturday afternoon ten busts of American science pioneers, presented by Morris K. Jesup to the American Museum of Natural History, will be unveiled and addresses delivered by representative scientists. In the evening a reception to the members of the association will be given by the trustees of the American Museum and the New York Academy of Sciences. The president of the association for the New York meeting will be W. H. Welch, of Johns-Hopkins University. J. J. Stevenson is the chairman and Prof. J. McKeen Cattell the secretary of the local committee of arrangements.

THE TECHNICAL PUBLICITY ASSOCIATION at its last meeting, at the rooms of the Aldine Association, New York, heard the report of its circulation committee consisting of Messrs. H. M. Davis, of the Sprague Electric Co.; C. N. Manfred, of the H. W. Johns-Manville Co., and Paul M. Wade, of the Standard Paint Co. The committee submitted a plan by which the Association will collect information about trade and technical magazines which will be treated confidentially and be used by the members only. It is believed that this plan will save time and trouble for magazine publishers as well as the advertisers. The advertising departments of the following companies were also represented: John A. Roebling's Sons Co., American Locomotive Co., Yale & Towne Mfg. Co., Patterson, Gottfried & Hunter, American Wood Working Machinery Co., General Electric Co., Crocker-Wheeler Company, A. S. Cameron Steam Pump Works, B. F. Sturtevant Co., M. H. Treadwell Co., and Robins Conveying Belt Co. The next monthly meeting of the Association will probably be devoted to a discussion of catalogues, circulars, etc., and will take place Dec. 20.

CHICAGO TROLLEYS.—At last an agreement has been reached between the city of Chicago and the traction companies for settlement of the entire traction question on a basis of ultimate purchase by the city for $50,000,000. The city obligates itself when it gets ready to take over the properties to pay $29,000,000 for the property of the Union Traction Company and $21,000,000 for the City Railway. In the meantime the Chicago City Railway Company and the Chicago Street Railways Company will enjoy an indefinite franchise and operate the roads. The city will have the right of purchase at any time on giving six months' notice. The companies will be entitled to 5 per cent. brokerage in raising the necessary $40,000,000 for rehabilitation. Five per cent additional is allowed for interest on the entire investment. Ten per cent is allowed the companies for contractors' profit on their work of reconstruction, on the theory they are doing it for the city. This includes the purchase of cars. The city and the companies are practically in a partnership, the companies taking 45 per cent of the net profits and the city the remaining 55 per cent. The work of rehabilitation and operation will be supervised by a joint board of engineers, one of whom the aldermen and traction men agreed should be Mr. Bion J. Arnold, who has furnished expert information on street car questions to the City Council during the last ten years. Subsequently the city and the companies will each appoint an engineer to sit on the commission.

SPIRIT TELEGRAPHY.—With regard to the statement that Mr. Marconi has become a spiritualist, a special cable dispatch from Rome, of December 15, says: "The conversion of Signor Marconi to spiritualism by Princess d'Antuni del Drago, who has the reputation of being a medium of exceptional power, has caused a sensation among believers in communication between the seen and the unseen world. Mr. Marconi has always been regarded as intensely practical. He was not known to take an interest in anything outside of the material and scientific except art and history. There is reason to believe that he became interested in the study of wireless messages to the other world by the declaration of Lombroso, the alienist professor of psychiatry in the University of Turin, in which, he said, the subject was of colossal importance. The Princess d'Antuni del Drago says she has held seances in her own palace and has been favored with extraordinary phenomena. 'I met Marconi a few weeks ago,' she remarked, 'at an entertainment given by Marchioness Pinolecee. He said he did not believe in spiritualism. I invited him to my house to assist in a seance. He was one of three. A medium called Politi and I, with Marconi, formed a circle around a small table. Without relating all that took place, suffice it to say that when Marconi left he had been convinced so fully that he determined to study the subject scientifically, and promised to place me in communication with Prof. Crookes. I am anxiously awaiting to learn if the great inventor has found any explanation for the phenomena.'"

Hydro-Electric Developments at Huntingdon, Pa.

THE two plants now being constructed by the Juniata Hydro-Electric Co., near Huntingdon, will form part of one of the most important electric transmission systems in Pennsylvania. The main plant of the present development is located near Warrior's Ridge Station, four miles from Huntingdon, and the other is 2.5 miles farther down the river in the direction of Huntingdon. The work on the former plant includes the construction of a dam nearly 400 ft. long, securing an effective head of 28 ft.; a reinforced-concrete power house 30 by 205 ft., with two wings 78 by 45 ft. and 78 by 26 ft., and the installation of a combined hydraulic and steam plant which will be capable of generating, when the installation is complete, about 8,000 hp. The estimated cost of the completed Warrior's Ridge plant and installation is approximately $425,000, while the total cost of the two developments, including transmission losses and sub-station, will be in the neighborhood of $1,000,000. The intention is at present to supply from the Warrior's Ridge plant 3,000 kw generated by hydraulic power with two 500-kw steam turbo-generators to furnish the additional power required.

The dam, which was designed by the Ambursen Hydraulic Construction Co., has a rollway 375 ft. long, and is 57.5 ft. wide from outside to outside of cut-off walls. The height, measured from the bottom of the dam floor to the crest, varies somewhat owing to the floor being stepped up or down, depending on the nature of the bearing material. The maximum height is 27.5 ft. and the minimum 22.5 ft. Fig. 2 shows the form of the dam section and its general dimensions. In each bay, weep holes are provided in the floor to remove any upward hydraulic pressure, and a drain pipe through the concrete below the bucket carries off seepage water. In each buttress are two rectangular open-

FIG. 1.—VIEW OF DAM DURING CONSTRUCTION.

ings. A plank walk carried through the upper series of openings serves as a passageway for the inspection of the inner surfaces of the dam. The lower openings are for construction convenience only. The dam is reinforced throughout with .75-in. corrugated iron bars.

A sectional view of the power house is given in Fig. 4. It will be noted that the generators, boilers, steam turbines and transformers are all on the main floor of the building. Below this floor the concrete is without reinforcement, but above the floor the structure is built entirely of reinforced-concrete with the exception of the east wall of the generator room and the portion of the west wall above the dam wall in front of the turbines. These two walls are formed by vertical I-beam columns with expanded metal and plaster on both sides. There are eight wheel flumes between the south end of the building and the south wall of the electrical wing. The two nearest the wing are for exciter turbines and are only 6 ft. wide. The remaining six are for the generator turbines and each is 15 ft. wide. Since, as seen in Fig. 5, the west wall of the electrical wing will be subjected to external hydraulic pressure it is reinforced with rectangular counterforts 2 ft. thick extending 11 ft. 3 in. beyond the building and spaced 10 ft. center to center. On the east

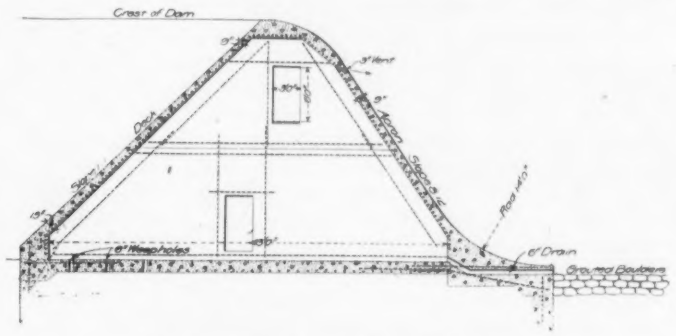


FIG. 2.—SECTIONAL ELEVATION OF DAM.

side of the boiler house are eight coal pockets over the tops of which a trestle switch track is to be run from the Pennsylvania Railroad. The total storage capacity is about 5,000 tons within easy shoveling distance of the boilers. The coal is delivered to the boiler room floor through doors with hinged gates by which the flow can be regulated. The entire roof of the power house is constructed of cinder concrete 4 in. thick reinforced with expanded metal, 10 gauge, 3-in. mesh, and is to be covered with tar and gravel.

Foundations have been constructed for four boilers in batteries of two each, one battery on each side of the stack. At present only one battery is to be installed. Atlas 400-hp water-tube boilers are to be used. The boilers are guaranteed to deliver steam at from 20 to 40° above saturated condition and for this reason and also because the steam plant will probably be idle except during low water seasons no superheaters are to be installed. A sluiceway passes through the ash pits and the ashes and clinker will be flushed through this into a perforated hopper with a dump bottom on the tail race side of the boiler wing. The finer material will fall into the race, but the clinkers retained in the basket will be dumped into a scow and floated away.

FIG. 3.—EXTERIOR OF POWER HOUSE, SHOWING WHEEL FLUMES.

The stack was built by the Weber Steel Concrete Chimney Co., of Chicago. It has an inside diameter of 7 ft. and a height of 175 ft. above the boiler room floor, and is designed to accommodate the final installation of four boilers.

The steam turbine room has foundations for four turbo-generators. The turbines are of the Curtis two-stage vertical shaft type with cast-iron exhaust chambers in the base for bolting directly to the condensers. The step bearings are oil lubricated, two steam-driven oil pumps being installed, either one of which can supply the complete final installation. To provide against accidental stoppage of the oil pumps and the consequent damage to the step bearings, a 20-gal. accumulator is being installed. The

turbines have relief valves which discharge into a 16-in. free atmospheric exhaust pipe passing out through the roof.

There are in the present installation two complete condensing equipments, one feed-water heater, and two feed-water pumps. The condenser auxiliaries are so arranged that any one of the set can operate with either condenser or in case of emergency one set can handle both condensers at a somewhat reduced efficiency. The condensers are of the Worthington counter-current, surface type, having a cooling surface of 1,750 sq. ft. each, and are operated with Worthington center crank, rotative, dry vacuum pumps, with air and steam cylinders arranged in tandem. No circulating pumps are needed, as the water for the condensers is taken directly from the head water through an 18-in. pipe, which is attached to a 16-in. header from which a 10-in. pipe supplies each condenser. By carrying the 16-in. discharge pipe under the surface of the tail water the full head of 28 ft. is secured. The feed-water heater is of the open type rated at 1,600 hp, and will serve the complete installation. It was made by the Warren Webster Co., of Camden, N. J. The two feed-water pumps are each 9 by 6 by 10-in., duplex, manufactured by the Platt Iron Works, and either one can pump hot or cold water or one hot and one cold simultaneously, if so desired. Two Worthington motor-driven, centrifugal pumps deliver water from the hot well of the condensers to the feed-water heater. The high-pressure steam piping is designed for 200 lb. working pressure and all fittings and valves are extra heavy. The pumps and other auxiliaries except the feed-water heater are to be installed in the basement of the steam turbine room on the side nearest the boiler room.

Four 500-kw, three-phase, 60-cycle generators are being installed, with provision for two future units. These generators are of the horizontal shaft, revolving-field type and are directly connected to a pair of 39-in. S. Morgan Smith wheels, running at 200 r.p.m., and rated at 1,000 hp at full gate opening. Each of these units is equipped with a Lombard governor, which maintains close regulation. The generator voltage is 2,300 and the guaranteed efficiency under normal load is 94 per cent. The design of these machines is very liberal, electrically as well as mechanically, and while guaranteed for 50 per cent overload for two hours, they may be expected to operate satisfactorily at this load for even longer periods.

Each of the two steam turbine generators, which are now being installed, has a rating of 500 kw and runs at a speed of 1,800 r.p.m. Their overload capacity is identical with the hydraulic generators. The high overload capacity of the hydraulic generators as well as the auxiliary steam plant is of value in meeting peaks and sudden demands on the transmission system. The armatures of both types of generators are star-connected and provision is made for grounding the neutrals, if so desired.

The exciter system consists of two 75-kw, 125-volt compound-wound exciters, each direct-connected to a pair of 15-in. S. Morgan Smith water wheels rated 150 hp running at 600 r.p.m. and full gate. Each exciter unit is equipped with Woodward mechanical governors. Either of these units is capable of furnishing excitation for the entire plant. Arrangements have been made so that it will be possible to install in the future an induction motor for direct connection to one of these exciter generators, at the same time disconnecting the water wheel. This provision was made on account of the possible danger of anchor ice. The exciter units will be used mainly for the purpose intended and their only duty as auxiliaries will be to operate the electric crane and to charge storage battery for operating oil switches. The lighting of the power house and the driving of motor auxiliaries will be by alternating current. A number of emergency lamps will, however, be connected to the storage battery.

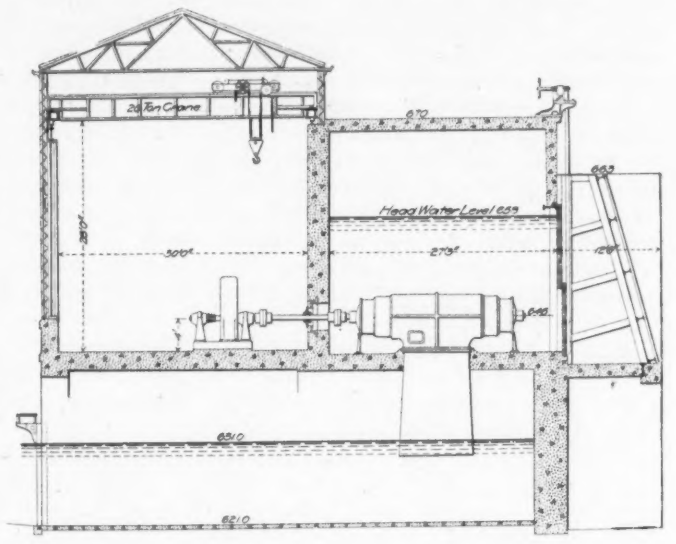


FIG. 5.—ELEVATION OF HYDRAULIC GENERATOR WING.

The generator voltage is stepped up to the transmission e.m.f. of 11,000 and 45,000 by two banks of water-cooled, oil-insulated transformers, each bank consisting of three 500-kw units of similar design as to heating and overload capacity as the generators. These transformers are arranged for star connection on the high-tension side and the neutral point will normally be grounded. The 11,000-volt current is taken from the main winding by a tap connection. The cross-section of copper in this part of the

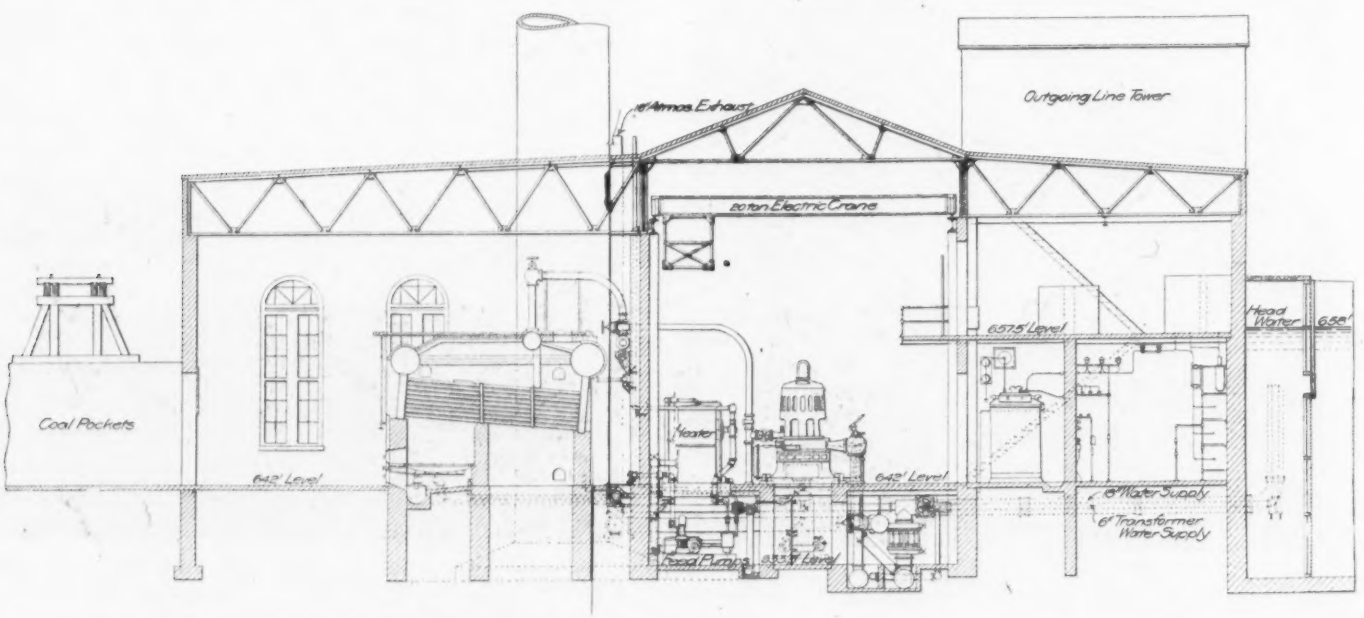


FIG. 4.—CROSS-SECTIONAL ELEVATION OF BOILER ROOM, GENERATOR HOUSE AND TRANSFORMER COMPARTMENT.

winding is greater than in the remainder to allow the desired load to be taken at the lower voltage. This arrangement permits 500 kw normal load to be taken from each bank at 11,000 volts simultaneously with 1,000 kw at 45,000 volts, or no load at 11,000 volts and 1,500 kw at 45,000 volts, or any combination between these points. As the transformers are capable of 50 per cent overload for two hours, these figures may be increased by that amount when meeting peaks. The guaranteed efficiency of these units at full load is 97 per cent. Each end of the high-tension winding for 10 per cent of its length, as well as the tap connection, is protected by special insulation between turns. This precaution is taken to meet possible break-downs from static strains and lightning. Heat generated due to iron and copper losses is carried away by cooling coils in the transformer tanks. Water is circulated in these by utilizing the natural head of 28 ft., the discharge being carried under tail water. This obviates any dependence on motor-driven circulating pumps. Seven transformers are installed, each in a separate concrete compartment, as indicated in Figs. 4 and 6. Each compartment is protected in front by rolling steel blinds. This construction is as near fire-proof as possible. The extra unit is placed between the two banks

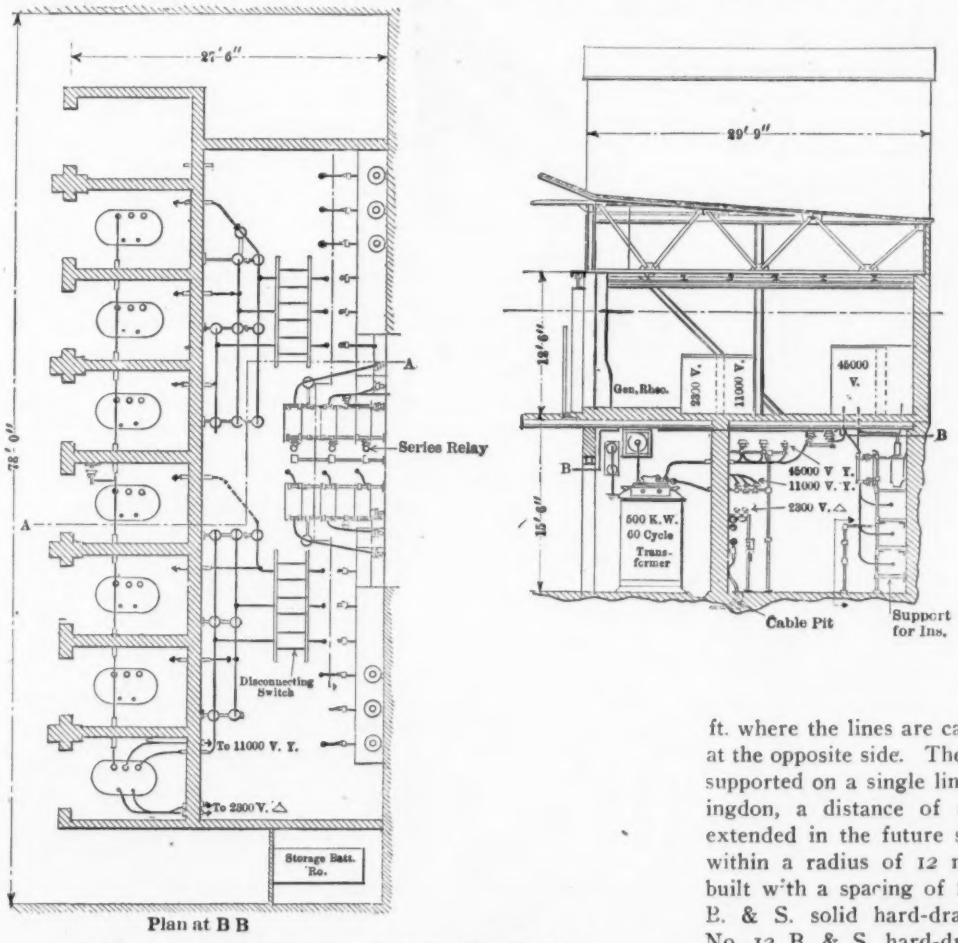


FIG. 6.—PLAN AND ELEVATION OF HIGH-TENSION ROOM.

serving as a spare to either bank. Auxiliary 11,000 and 45,000-volt buses are installed enabling a defective transformer to be disconnected and the spare connected in without removing from the compartment.

The low-tension cables from the generators are carried in fibre conduit laid in the concrete floor. They are three-conductor cables of varnished cambric, lead-covered. The 125-volt exciter and field lines are insulated with rubber and braid, and are carried in a similar manner on the concrete floor. The high-tension buses are of bare copper wire, and contrary to usual practice are exposed, being separated by concrete barriers and a liberal spacing. The three sets of bus-bars—2,300 volts, 11,000 volts and 45,000 volts—are equipped with sectional oil switches and the outgoing feeders are divided between the two sections, thus allowing the station output to be transferred from one feeder to another as desired. The low-tension switches are hand-operated from the board. Each of the 11,000-volt switches has three single elements, and is solenoid-operated from the board, while the 45,000-volt switches are motor-operated. Both the latter types have indicating lamps on the board for showing switch position. Both the 11,000 and 45,000-volt feeder switches are provided with time-limit relays, but the generator switches are not so equipped. All oil switches are placed in concrete compartments back of the switchboard and on the same elevation. All outgoing lines are protected with the latest multiplex type of lightning arresters.

The switchboard consists of 20 slate panels 20 in. wide, including four blanks, and is mounted on a gallery or platform overlooking both the hydraulic and the steam generating rooms, and at a height of 15.5 ft. from the main floor. The switchboard contains ten generator panels, including blanks, two exciter panels, a station and bus section panel, a direct-current auxiliary panel, an alternating-current auxiliary panel, two transformer and two feeder panels and a combined feeder and inductor motor panel. The station output is metered on the low-tension side, and each feeder panel is equipped with a curve-drawing wattmeter, thus furnishing a continuous record and enabling the station load factor to be determined with ease. A Terrill regulator is installed on the station panel to control the line voltage. The synchronizing is done on the low-tension side of the transformers. All of the electrical apparatus was furnished by the General Electric Company, of Schenectady, N. Y.

The power house is equipped with a 20-ton, three-motor electric crane operated with current from the exciter generators. This crane has a span of 31 ft. and runs the entire length of the steam and hydraulic generating rooms. It has sufficient capacity for handling any piece of apparatus installed without dismantling. The crane was built by Alfred Box & Co., of Philadelphia.

The outgoing feeders, consisting of two 45,000-volt and three 11,000-volt lines, are carried from an outgoing tower at the south end of the electrical room directly over the wheel pits, as shown in Figs. 4 and 7. A heavy terminal tower substantially anchored into the concrete of the wheel compartments supports the wires at a height of about 50 ft., and takes the strain of a span of approximately 400 ft. where the lines are carried across the river to a similar tower at the opposite side. The lines here divide, two 11,000-volt feeders supported on a single line of wooden poles running east to Huntingdon, a distance of about five miles. These lines may be extended in the future so as to take in other towns to the east within a radius of 12 miles from the plant. The pole line is built with a spacing of 135 ft., and the circuits consist of No. 4 B. & S. solid hard-drawn copper. The telephone line is of No. 12 B. & S. hard-drawn copper mounted on brackets 6 ft. below the lower cross arm. The remaining 11,000-volt line is carried on the steel towers in the direction of Altoona for supplying local industries in that direction.

Two 45,000-volt transmission circuits are being built from the station to the cities of Tyrone and Altoona, distant about 15 and 30 miles, respectively. These are carried by steel towers, on each of which are two circuits of No. 2 B. & S. seven-strand, hard-drawn copper cable, supported on Locke No. 344 porcelain insulators having a diameter of 12 in. and a height of 12 in. The towers for the transmission line are made of steel angles, all heavily galvanized after the completion of machine work. The footings are set 6 ft. in the ground and the cables are supported at a height of 40 ft. and 46 ft. above the ground, each set of conductors constituting an equilateral triangle with 6-ft. sides. A bent channel at the top forms a horn lightning arrester with the line wire, this type of protection being deemed cheaper than, and as satisfactory as, a ground wire. Each tower is equipped with this device, and it is also thoroughly grounded by a metal

plate in addition to the ground furnished by the footings. The standard spacing between towers is 440 ft., or 12 to the mile, but longer spans are being laid out, with higher towers of heavier construction to afford the requisite increase in strength. They were built by the Rites-Conley Manufacturing Company, Pittsburg, Pa.

The insulators are made in four parts and are shipped from the factory crated, three insulators per crate. This allows an easy means of distribution along the line, as two crates can be left at each tower for mounting on the six pins. The insulators are cemented at the factory, but only after each part has been tested to 45,000 volts while wet. The assembled insulator is tested dry to 125,000 volts, and a representative number also tested to 90,000 volts under a severe precipitation. The pins are set in the insulators in the field with wet Portland cement before their removal from the crates.

Each conductor is of seven-strand, hard-drawn copper cables approximately 0.3 in. in diameter and has a strength of 60,000 lb. per sq. in., and an elastic limit of approximately 40,000 lb. per sq. in. The sags and stress in the cables were estimated on the basis of 100 miles per hour of wind at right angles to the line and a working strength of one-half the elastic limit.

The telephone circuit consists of a No. 8 B. W. G. "river crossing" steel wire. This wire has a tensile strength of 4,000 lb. and was chosen on account of its great strength, the resistance

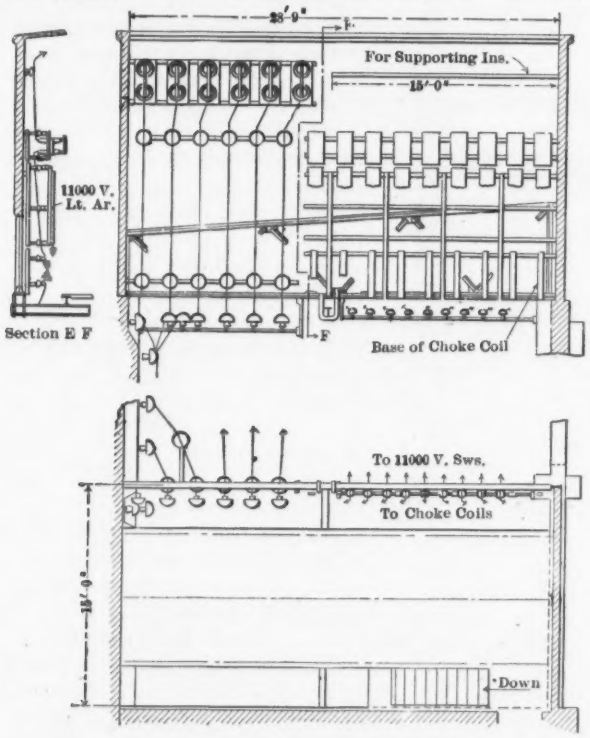


FIG. 7.—PLAN AND ELEVATION OF TOWER ROOM.

being sufficiently low for satisfactory operation on a line of this length.

Sub-stations are being installed at Huntingdon and also at Tyrone, and later one will also be erected in the city of Altoona. These buildings have not advanced sufficiently at the time of writing to warrant a description. It is the intention of the company to build other plants on the Juniata River and to transmit power east as far as Lewistown.

The complete building and hydraulic installation was designed by Mr. W. H. Cushman, the chief engineer of the Juniata Hydro-Electric Company, who also is in charge of construction work. The steam auxiliary plant was designed and laid out by Mr. A. C. Wood, of Philadelphia, acting as consulting engineer. The electrical installation was designed by the General Electric Company, who also acted as consulting engineers. The resident electrical engineer in charge of installation is Mr. J. L. Curtiss. The transmission line is under the direct charge of Mr. F. W. Scott, who is also superintending its construction. The Warrior's Ridge plants will be owned and operated by the Juniata Water & Power Company, a Pennsylvania corporation, of which Mr. H. Lansset Geyelin, of Philadelphia, is president.

Present Status of European Practice in Transmission Line Work.

The problems of transmission of electrical energy over long distances by means of overhead conductors have received the close attention of Swiss and Italian engineers from the earliest days of electrical engineering, and the following brief notes of their latest practice may be of interest to American engineers who are facing similar problems, some of which can be theo-

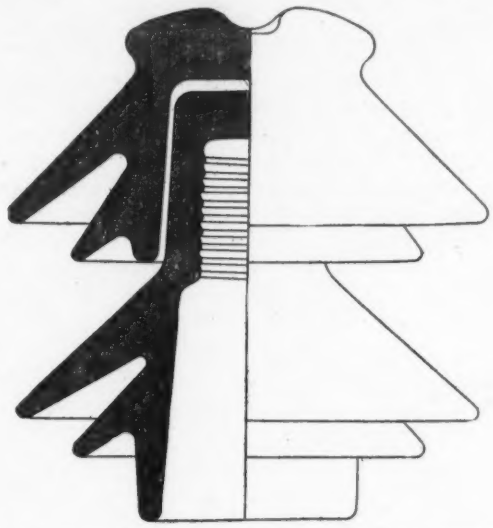


FIG. 1.—INSULATOR USED ON THE 30,000-VOLT PADERNO TRANSMISSION LINE.

retically solved, but a large number of which must find their solution by the method of trial and error.

The experiences of Mr. Charles Brown, one of the earliest workers in this field, the inventor of the horn-type lightning arrester and a pioneer of many of the more recent developments, are always of interest. He gives a word of warning to those engaged in insulator testing, claiming that most insulators have a very pronounced fatigue effect. Though an insulator may stand a given tension for 15 minutes, it may possibly break down at this tension if it is maintained for two hours, and he

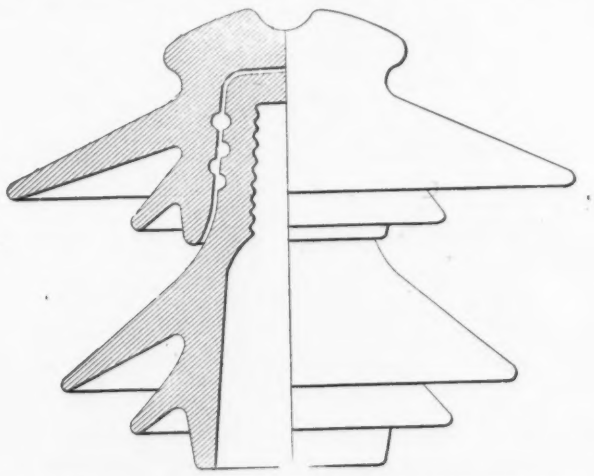


FIG. 2.—PADERNO TYPE OF INSULATOR RECOMMENDED FOR 40,000 TO 50,000 VOLTS.

recalls the great difficulty always experienced in attempts to deduce reliable results from any testing, except actual use on the transmission line.

He further states that very little trouble is experienced from heavy rain storms or climatic conditions causing insulator breakdowns, the trouble being almost entirely mechanical and due to lightning. Such mechanical defects as have been experienced are thought to be due largely to the use of cement for connecting the petticoats of the insulators together, since great difficulty is experienced in obtaining a cement which does not swell with increase of temperature and thus fracture the insulator. In Switzerland use is made of sulphur cement (when sulphur is

used, the pins must be galvanized) and plaster of Paris, both of which have given satisfaction. The latter, however, being somewhat porous, must be varnished with shellac wherever it is exposed to the air at the outside of joints, etc.

For fixing the pins of the insulators, tow or hemp is used which is twisted around the end of the pin, the whole being then dipped in asphalt or shellac and screwed into the insulator. Mr. Brown states that no splitting or fracturing of insulators occurs with this method of fixing the pins.

It is further stated that no good results have been obtained with the Fox cement, which is thought to have too high a coefficient of expansion, producing splitting troubles. In this connection, however, it should be noted that somewhat thinner insulators are used in Switzerland than in Italy, and the engineers of the latter country have found very little trouble due to this cause.

As long ago as 1887 the Brown-Boveri Company first tried "guard wires" on the Burgenstock line, placing a single wire above the transmission line because it was then considered that the top wires were the most affected. Lightning then began to affect the lower wires, so the guard wires were discarded, and generally speaking they are not at present favored in Switzerland.

In general the position in Switzerland is one of doubt, and it is not unusual to find a enormous variety of lightning arresters and lightning-arrester devices placed on the transmission line, partly because practice has shown that better protection than by one single system, is secured by the simultaneous use of different systems of lightning arresters on the same line, and partly in the hope that a more close study of their behavior will give valuable evidence.

Mr. Charles Brown has expressed himself as very pessimistic at present and considers that no thoroughly satisfactory arrester is yet on the market; but he holds at present in greatest favor the "Horn" type, the "Wurts" type and the "water jet" type. This latter is stated to be much in favor in Switzerland and is being widely used now; but since several of these jets must be

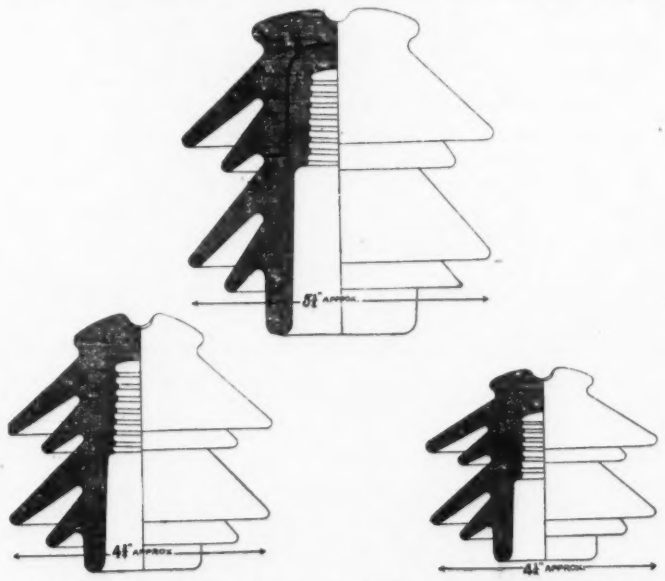


FIG. 3.—MODERN ITALIAN INSULATORS OF THE PADERNO TYPE.

used on a given system and each one may absorb from 10 to 20 kw, it is a matter for careful consideration before installation.

Trouble has been experienced due to dynamic shock shattering the wooden poles and insulators. It is ascribed to the presence of water underground and has been overcome by moving the transmission lines some distance to either side of the spot affected. Other Swiss experts have referred to the difficulty in the manufacture of perfect insulators, pointing out that minute holes in the enamel in the surface which can not be seen by the eye, may pass test, and then cause breakdown after some months' installation.

Some again claim to have overcome the difficulty due to insulator splitting, by using no cement at all, the insulator being made in two or more pieces which are tested independently and then screwed together and the whole rebaked.

They have also paid considerable attention to the exact shaping of the edges of the insulator petticoats, a rounded edge being considered very bad, since in a heavy rain storm it will cause the water to run under and drop on the surface of the lower petticoats. They at present very much favor a petticoat slightly turned up near the edge to check the velocity of the running water

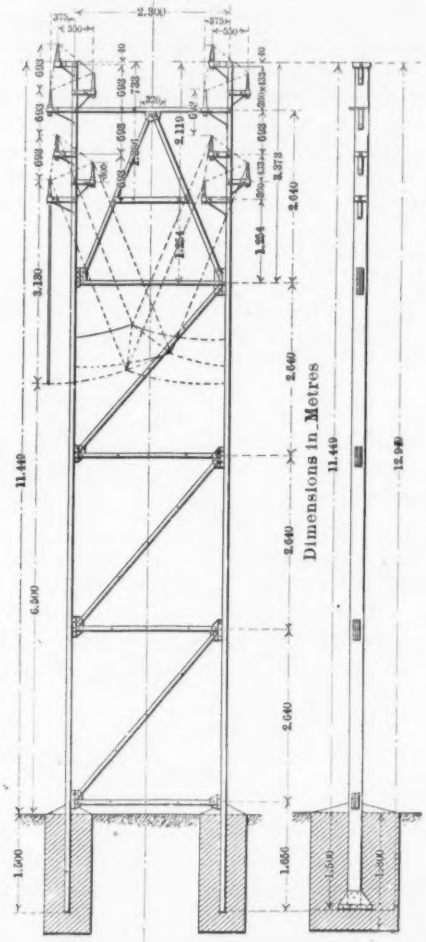


FIG. 4.—STEEL POLE USED ON TREZZO 15,000-VOLT TRANSMISSION LINE (DIMENSIONS IN METRES).

and then dropping to a sharp point on the extreme edge, which seems to prevent this running under. By this means it is considered that the effect of rain storms may be considerably reduced.

For all transmission lines for electromotive forces of 40,000 volts and above, iron poles are preferred and if the insulators have not more than two petticoats, wooden cross beams are used; if three or more, then they are placed directly on the iron poles.

In Italy, Mr. Guido Semenza, whose name is associated with the well-known Paderno transmission and with numerous others throughout the country, referring to his earlier experiences, stated that on the Paderno line, after some experiment, his conical type of insulator was chosen and a triple petticoat used, the line being, however, finally completed with two of these cemented together as one six-petticoat insulator. The dimensions of this were, height over all, seven inches; diameter of petticoat, 6¼ inches (Fig. 1). In other plants the Paderno type was then superseded by a much lighter insulator, but it has lately returned to favor and is in general use.

The actual Paderno insulator is shown in Figs. 1 and 2 and the effect of this type on Italian insulators is illustrated by Fig. 3, which shows sectional view of insulators considered standard for 6,000 volts, 8,000 volts, and 12,000 volts.

The actual trial on a transmission line of the new Semenza insulator, recently described in these columns, is being looked forward to with great interest, as it is anticipated that it will be widely used.

The mechanical splitting of double or triple insulators, due to the expansion of the cement used in joining them together, has not been experienced, but it is probable that this is due to the use of a thicker and stronger insulator than employed in Switzerland. The cement used in connecting the petticoats together is

generally composed of 10 parts of litharge and one part of glycerin.

Mr. Semenza considers that the problems connected with lighting troubles are not by any means solved. He has recently favored the Westinghouse low-equivalent arrester, Italian practice being at present somewhat against the use of any arrester which allows the arc discharge to be formed and then blows it out, since it is considered to tend to the production of serious surges.

With regard to the lightning discharges which produce shattering of wooden poles and insulators, this trouble has not occurred in Italy, since iron poles are used with this idea in view as one of their advantages.

Clipping of the petticoat rims of insulators has been experienced, but apparently does not materially affect their value. The greatest lightning trouble has been experienced from inductive discharges caused by lightning striking trees or nearby objects, since such a discharge sets up induced surges in the transmission line which cause flash-overs at the resonance points, thus short-circuiting the line and frequently cutting the rims of the insulator petticoats.

It is stated that some lines have given trouble due to the design of the line giving an inductance and capacity tending to produce certain resonance conditions at various points. This has been partially overcome by adding at several points new lightning arresters, and some experiments are now being made with special condensers placed at different points.

With reference to guard wires, it is interesting to note that in general, the fear of mechanical troubles has prevented their use in northern Italy.

The arrangement of the wires so that the arcs through which they swing, when moved by wind, do not interfere, has received much attention and when the triangular arrangement is used, the method shown in Fig. 4 is employed, which shows the conductors situated at the points of an equilateral triangle in which the base line is not horizontal. This figure also shows one of the standard iron poles used on the latest installation at Tretzo.

Engineer Semenza now uses a 110-metre span for general work and a 280-metre span is the longest he has used for isolated cases, such as bridging rivers, etc.

Fig. 5 was drawn from a map made especially for the balloon and air ship trials in connection with the Milan Exhibition in order that the aeronaut might avoid the danger of grappling irons coming in contact with the transmission lines, and gives an interesting idea of the dense network of transmission lines in

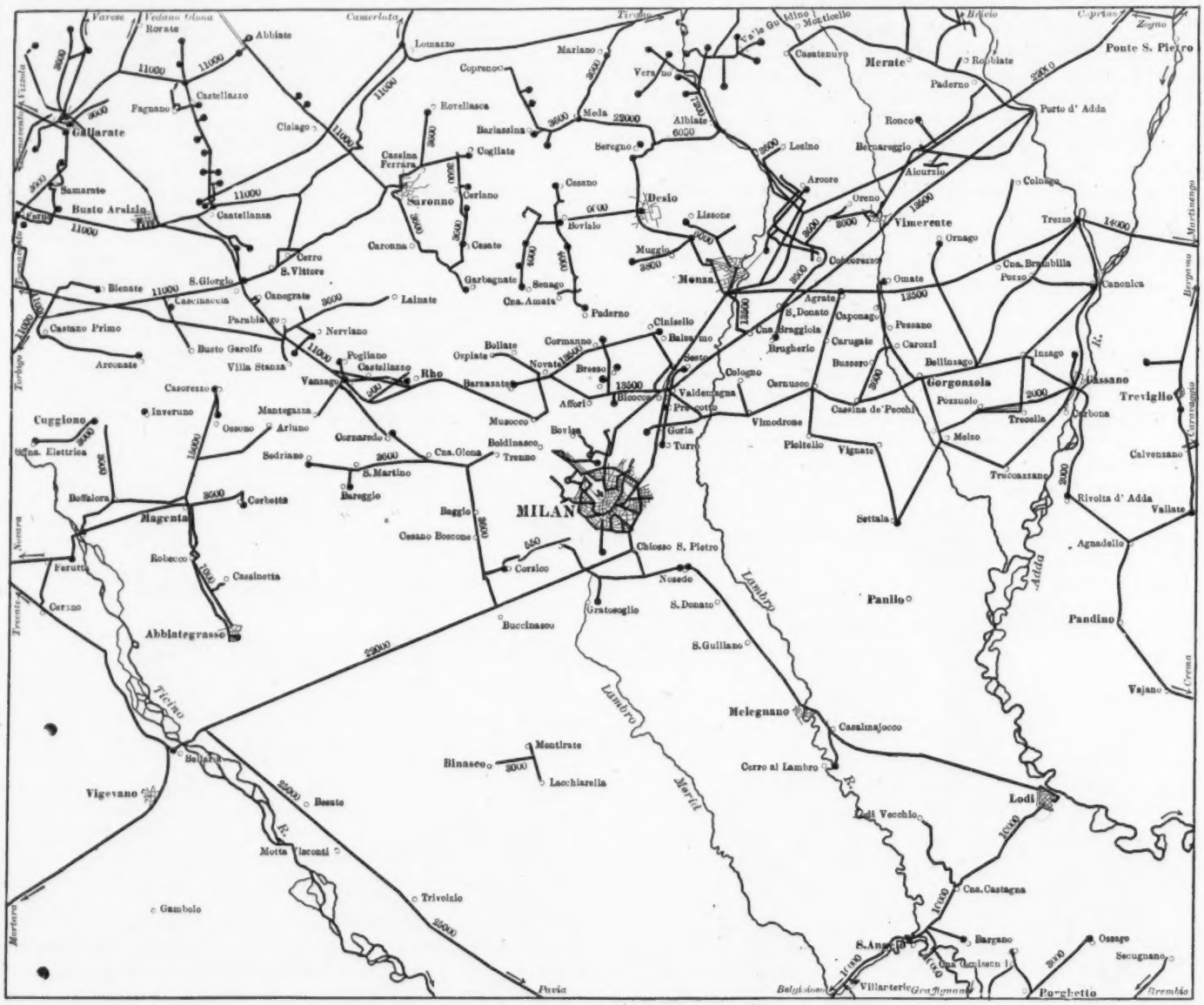


FIG. 5.—MAP SHOWING TRANSMISSION LINES IN MILAN DISTRICT.

northern Italy. From this map will be seen the rapid growth of transmission line work in Italy and will explain to some extent the rapid growth of such firms as Messrs. Richard-Ginori and Messrs. Pirelli, of Milan, who deal so largely with insulating materials.

While touching the subject of transmission of power in northern Italy, it is worth noting that practically no case whatsoever of hunting of alternators, when operated in parallel, has occurred there, and Italian engineers speak with astonishment at the references in the American technical press of a trouble practically unknown to them. Enquiry leads to the belief that the percentage line losses are about the same as those employed in America, but the absence of these troubles is frequently due to the remarkable pitch of perfection to which both engine and water turbine governors have been brought. In this connection, it may be of interest to recall that the standard frequency in northern Italy is 42½ cycles.

The Design of Induction Coils.

BY WM. O. EDDY AND MELVILLE EASTHAM.

THIS article enumerates and discusses the various factors that should be considered by the maker or designer of effective and efficient induction coils, without allowing theoretical considerations to outweigh manufacturing difficulties and the cost of the construction. The object intended is to present the theory relating to the essential components of a coil and their mutual relations, as well as facts learned from experience in the building of induction coils. No attention is given to the history of the development of the coil making art, or the enumeration of well-known early coils and data on their construction, which fills the chief space in the usual article on this subject.

The first consideration in the design of an induction coil is the purpose for which it is to be used, whether it is to be a spark coil for the ignition of the mixture in a gas engine, a large experimental coil for a physical laboratory, or a small coil for telephone work. Consideration will be given here to only that class of coils which has a separate primary and secondary, unconnected and insulated from each other, and which will be capable of giving at least a four-inch discharge between secondary terminals.

The chief application of such a coil is, at the present time, the transmitting end of a wireless telegraphy station or the exciter for the generation of Röntgen rays. It is toward the design of such coils that these notes are intended especially to apply.

For both of these two classes of work there are other considerations more important than the mere sparking length. For example, a coil with a secondary potential that will throw only a nine-inch spark will, if properly designed, give more powerful X-rays than the avearge sixteen-inch coil run on the same circuit, and using the same amount of power. Manufacturers have in the past prided themselves on being able to obtain a certain spark length with a minimum number of pounds of secondary winding. The only claim for recognition that such a coil has is that it can show a long spark jumping between terminals, but for efficient and effective usefulness it has none.

It is deplorable that the rating of induction coils should be only by the spark length. It would be just as sensible to rate transformers only by the potential of their secondaries, and to speak of a 40,000-volt transformer without stating whether its capacity is one-half or 5,000 kw. The explanation of the present plight seems to be that for years the high-potential induction coil has been a scientific toy, an apparatus for producing only a long spark for spectacular or experimental purposes, without reference to the efficiency of transformation or the amount of power required. Being worked only for a short time, the heating of the coil was not a consideration and the strength of the secondary current was unimportant. The makers bent their competitive energies toward that design which would give the highest potential with the least weight of wire and size of coil. These traditional considerations have, until recently, been the gospel of the induction coil builder, and the small amount of real knowledge of the requirements and the underlying principles of design possessed by the average manufacturer is truly remarkable.

Now that the induction coil has become an apparatus of commercial value it is high time that it had a real and definite rating which should show in some way for a stated primary input the output of the secondary, as well as its sparking distance; and also the safe watt capacity of the coil with reference to a time and temperature factor.

The design of an induction coil is more or less of a compromise and involves several problems: (1) The varying conditions under which the coil is to be used, make it necessary to design for a wide range of operation; (2) each separate factor cannot be designed for its own best efficiency in one direction without at the same time seriously influencing another part of the coil or another function of the same part; (3) the cost and manufacturing expediency must be carefully considered. The first problem is solved in part by designing for the average work required of the coil and by making the inductance of the primary and the capacity of the condenser each adjustable. This adjustability feature is too often neglected, although the advantages usually outweigh the disadvantages that can be brought against it. It is one of the aims of this article to discuss the second problem, leaving out those theoretical considerations which are impractical from the standpoint of the third problem.

For the design of an induction coil there are no definite methods or fixed rules; the present type has been rather the result of development. The coil proper has for its essential parts a primary wound over an iron core; an insulating tube over this primary, and a secondary winding outside of the insulating tube. These essential parts will be discussed separately.

THE CORE.

Closed magnetic circuits for induction coils are not practical because the magnetism will not die down with sufficient rapidity, while partly closed circuits of the hedghog and I types have not proved as yet entirely satisfactory, although development along this direction may be expected. Various attempts to use finely divided iron for closing the circuit have not been successful, for though iron in this state will follow rapid oscillations, it has such a low permeability that its merits do not balance its disadvantages.

The core should be composed of a bundle of soft iron wires, of as high a permeability as possible, in order to be capable of receiving a high degree of magnetization and thus create a powerful field. The character of the iron should be such that its hysteresis loss is small.

The smaller the wire the smaller the eddy-current losses, and the less the heating of the core, but the less effective it will be since, for a given cross-section, there is a less amount of iron, due to the greater amount of oxidized surface and the permeability of the core as a whole is therefore diminished. If a larger diameter of core be used to atone for this, there will be required to wind around it, per turn, a greater length of secondary wire with its consequent disadvantages. Experience seems to indicate that the best average size of core wire is about No. 22 B. & S.

The strength of the eddy currents generated in the core are proportional to the speed of interrupter in the primary circuit. Therefore, the resistance in the path of these currents should be increased at the expense of space, the higher the speed of interrupter to be used; and for this reason, for an extremely rapid break, even a layer of rust on the wire may not be sufficient, and each wire may be dipped in some kind of insulating varnish. With respect to the size of the core also we should consider the interrupter to be used. If it be a rapid one it may be too fast for a core of large diameter, which requires a longer time or a stronger current to fully magnetize it, and near saturation is the best point at which to work. Again, the magnetism penetrates from the outside, and it is analogous to the "skin effect" on a conductor carrying high-frequency currents and may not reach the center of the core at all for an extremely rapid vibrator, in which case a hollow cylinder would serve as well as though it were solid. These points, together with the fact that the slower the interrupter the less the hysteresis losses, argue for a slower interrupter. This point, however, will be taken up later.

THE PRIMARY AND THE CORE.

The primary and the core are so intimately related that they should be discussed together; a change in either will necessitate a change in the other. Consider an open magnetic circuit, straight and cylindrical in form, which for its magnetism will be dependent upon the number of ampere-turns surrounding it. This factor being the product of the current and the number of convolutions of wire, attention must be paid to the number of amperes the coil is to take, which in turn would necessitate a discussion of the voltage, and the type and speed of the interrupter, and soon we would be lost in the secondary winding and the condenser in an attempt to find the most efficient compromise for the whole coil. We will endeavor, however, to confine ourselves to one point at a time so far as possible, and to discuss its relative effects on the other factors. We will, therefore, assume that the current is a fixed quantity, which means that we will have to give for the required magnetization a definite number of turns to be wound over the core, and it is important that this primary winding should take up the least possible amount of cross-sec-

tional space, so that the secondary may be placed close to the core where the field is strongest.

The dotted lines in Fig. 1 show the lines of force as they would be found by the well-known method of allowing iron filings to arrange themselves about a straight open-circuited iron core magnetized by a winding, as shown. It is seen from the diagram that most of the lines bend at the end of the winding to return to the opposite pole by the shortest path without emanating from the extreme end of the core; thus we see that there is no object in having the core much longer than the primary winding, which should extend nearly its full length.

In experimenting with the primary and core the effect of the secondary may be considered almost negligible if it be kept open-circuited, so that no sparks may pass. If current be allowed to flow in the secondary the inductance of the system is decreased, and with the terminals short-circuited the mutual induction between the primary and secondary renders the inductance of the primary circuit of little comparative value, and calculations and measurements of the primary inductance alone are almost worthless. In considering the design of the primary and core we must take into account the volume of current that is to be used from the secondary, and that design which will give the longest spark across the resistance of the air is not the best with a different resistance or where current is used to charge a condenser.

Some experimenters have suggested that the best ratio of the diameter of the core to its length should be about one to twelve, but they seem to have been aiming only for great length of spark; a better ratio for a coil for average work would be from

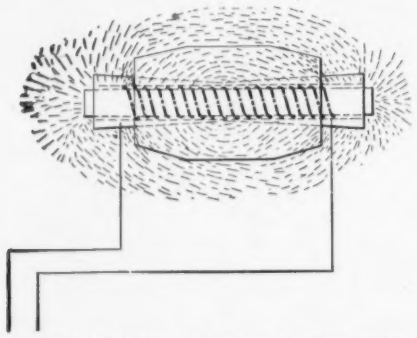


FIG. 1.—LINES OF FORCE AROUND AN INDUCTION COIL.

six to ten times the diameter for the length of the core. This ratio should depend on the interrupter and the size of the coil, and should not be the same for a large as for a small one.

Fig. 3 shows the curves of the primary current and the resulting secondary current under nearly perfect conditions with a slow interrupter; the curve for the primary being above the line and that for the secondary below. The ordinates of these curves represent the increase and decay of the currents, while the abscissas represent time intervals. It is only the magnetic change at "break" that produces useful current in the secondary, the magnetic change at "make" giving a reverse current that we would gladly dispense with if possible. If there were no iron in the circuit the current would reach its full value practically immediately, as shown by the dotted line on the representation of the first wave of the primary curve. The greater the inductance of the circuit the slower the current rises, and as here shown it is allowed, before "break" takes place, to reach practically its full value and become constant with the core fully magnetized; during this time the reverse current in the secondary has become zero. The breaking of the circuit is represented as being instantaneous—which is too ideal to be true—and as this occurs the primary current becomes zero while the magnetic field "collapses," throwing its energy into the generation of the useful current in the secondary, which in turn is allowed to become zero before "make" again takes place. The dotted line on the second wave represents ineffectual attempts to make and break the circuit by the average vibrating hammer interrupter; this of course will have its effect on the wave form of the secondary. The dotted line on the third wave represents the oscillatory discharge of the condenser across the gap, as found with the Braun cathode ray tube.

It will be readily appreciated that if the interrupter on this same circuit works too fast, the make-and-break curves of current will run into each other, break occurring before the primary current has reached its maximum value and before the reverse current in the secondary has died away, the next make reversing part of the useful secondary current and the whole coil working inefficiently.

Fig. 4 represents the primary and secondary curves with a rapid electrolytic interrupter in an extreme case as found by

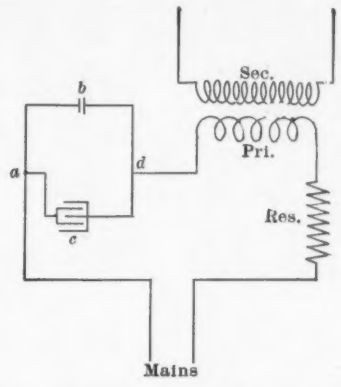


FIG. 2.—CIRCUITS OF AN INDUCTION COIL.

Armagnat in a most interesting set of tracings obtained with a Blondel oscillograph. With this rapid type of interrupter the curve of increase of the current in the primary is very steep and is sharply reversed when the break occurs. This rapid increase causes the reverse current which is produced in the secondary at "make" and also its sparking distance to be, as illustrated for an extreme case, nearly as great as at "break." Of course with every coil the current in the secondary tends to prevent the swift demagnetization of the core at break. With the electrolytic interrupter the reverse current is lessened with sufficient self-

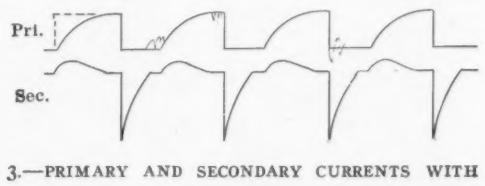


FIG. 3.—PRIMARY AND SECONDARY CURRENTS WITH SLOW INTERRUPTER.

inductance in the primary circuit, either by a larger core or by ample primary turns.

In this connection we might call attention to the point that the speed of break is entirely different from the rapidity of oscillation of the interrupter. The latter will determine the number of discharges that can be obtained from the coil per second, and, usually, the time allowed for magnetizing the core, but a rapid interrupter does not necessarily mean a rapid speed of break, which cannot in any case be too rapid, the ideal condition being to have this absolutely instantaneous.

A rapid mechanical break should be so designed as to give as long time as possible after the circuit is made instead of having the extra interval come after it is broken. When the "make" is

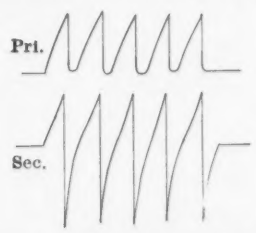


FIG. 4.—PRIMARY AND SECONDARY CURRENTS WITH RAPID INTERRUPTER.

short the amperage must be great in order to sufficiently magnetize the core in so short a space of time. This is obtained by running the coil on a higher voltage for a rapid interrupter or by cutting resistance out of the primary circuit.

The faster the interruption the harder it is on the interrupter, although the observed primary current is smaller. This is a point usually not realized by manufacturers, since the ammeter

in the primary circuit measures only the average current, and does not register this excessive current which flows only for a brief space of time. Often the secondary voltage may be increased by increasing the speed of the interrupter; but this is because with the increased speed the speed of "break" is increased also.

A slow interrupter with a quick break will give excellent results in an X-ray tube provided it is not so slow as to show a flickering with the fluoroscope. A larger amount of current can be used with a tube across the secondary than on open circuit, since the effect of the secondary when delivering current is to lessen the inductive effect of the primary and allow the primary current to reach its maximum value in a shorter space of time. An extremely rapid interrupter is not advantageous in wireless telegraph work for reasons that will be mentioned later. The importance of considering the nature of the interrupter in designing a coil may be seen by the frequency with which it is necessary to mention it.

Of course the curves shown in Figs. 3 and 4 would be influenced by the character of the load on the secondary and the tracings that would be obtained from the average coil as ordinarily used would be far from ideal.

To sum up the discussion of the primary and the core the writers suggest or recommend a larger core in both length and diameter and a larger number of ampere-turns than has been the custom in standard commercial practice, thus producing a powerful field which is the first essential in the design of a coil which is expected to deliver a large amount of energy and do useful work. It is noteworthy that in some of the more recent models this course has been taken, and the coils made according to the new design show improved results.

THE PRIMARY.

The primary winding should have regulating taps brought out from it at least at the end of each layer. The greater the number of primary turns, the larger must be the number of secondary turns to obtain a given potential.

The primary wire should be of a size large enough to carry, in its enclosed position, the maximum amount of current that the coil is expected to handle, although induction coils are seldom worked at their full capacity for any great length of time. The larger the amount of current put through the primary, the greater will be the power output, and also the potential. Other than for its heating effect the resistance of this winding is of little importance, since the inductive reactance far outweighs the ohmic resistance in its choking effect. Moreover, as shown in the theoretical connection diagram (Fig. 2), the coil is worked usually with a regulating rheostat in series with the primary.

Wire of square cross-section has been used, since it gives greater volume of copper for a given winding space, but owing to manufacturing expediency such wire is now abandoned in most cases, because of the difficulty of handling square wire on account of the danger that the insulation may become injured at the corners.

It has been found that a coil working on a 110-volt circuit may have induced a "kick-back" potential across the primary of over 2,000 volts; it is, therefore, necessary to keep the primary layers well insulated and to have sufficient insulation between the winding and the core.

For a twelve-inch coil—which has been considered somewhat a standard—which is to be operated from batteries where the volume of current is large, the size of wire should be from No. 8 to No. 10 B. & S.; while the same coil to be operated from the 110-volt circuit with small current would require No. 12 or No. 13. The number of layers and dimensions of core depend, as mentioned above, on the interrupter, the amount of primary current and the work required from the secondary.

THE INSULATION AND THE INSULATING TUBE.

The insulating tube is placed over the primary winding to insulate it from the secondary, and it should be as thin as its insulating qualities will permit so that the secondary may be placed as near to the core as possible. The material of which this tube is made should, of course, be a good insulator, but its specific resistance is of less importance (provided its dielectric strength is great) than the specific dielectric capacity, K; since the current passing between secondary and primary, due to the capacity effect, will be great in a high-potential coil as compared with the leakage current.

The thickness of the tube need be only great enough to withstand three-fourths of the secondary voltage, since for X-ray or wireless work there is almost never an absolute ground at one secondary terminal, and, even though the coil should be operated while grounded, the capacity of the coil is so much increased under the conditions that the current required to charge it will materially lower the potential.

When the coil is to be worked on open circuit or with a resistance the potential at the center of the coil is practically zero; therefore, we may apply Siemen's idea of decreasing the thickness of the tube at the place where the lines of force are strongest and the secondary turns are most effective, as shown in Fig. 1. This, although it adds complication, is often an advantageous practice in large coils.

The substances that may be used for this tube are glass, built up mica, gutta percha and hard rubber. Of these glass is easily broken and has perhaps the highest specific dielectric capacity combined with a comparatively low dielectric strength. Micanite has a high rupturing voltage, but also a high capacity, while both gutta percha and rubber have low capacity to recommend them.

The importance of the specific dielectric capacity (K) may perhaps be more evident by applying the equation $Q = CV$, where Q is the quantity of electricity that must be drawn from the secondary to charge the coil at each impulse before useful current can be drawn from it. C is the capacity of the coil (considering the primary and secondary windings to be the two conducting plates of a condenser) and is directly proportional to K, while from the formula it is seen that this quantity of electricity required increases directly as the voltage of the secondary winding. With a high speed interrupter and a large high potential coil this factor is of great importance, and upon the capacity and the insulating powers of the tube will depend very largely the maximum voltage that the coil will withstand and energy it will deliver.

We will mention here a well-known experiment performed with high-frequency currents of placing two pieces of plate glass, parallel to each other and separated by an air space of an inch or more, while the two terminals of a high-frequency machine are connected to their outside faces. The high-frequency spark now jumps across the air space between the glass plates without puncturing the glass. The explanation of this phenomena is that because of the high K of the glass the current is transmitted through it as a condenser would allow it to pass, while air having a value for K of only unity must allow this current to pass in the form of an actual spark. A comparatively thick sheet of any insulator, possessing a low K, placed between these glass plates may be ruptured in the same way, without injuring the glass, by a current of high enough frequency. By applying this principle we see the advantage of having K nearly uniform throughout the insulation of a coil. With a high speed interrupter and a heavy current little sparks may be seen inside of the insulating tube jumping into the primary winding, and for this reason a very large coil should have this small air space filled with some kind of insulating compound.

In connection with the insulating tube will be discussed the insulation of the secondary, which is required between and outside of the sections or "pies" of the secondary winding. For the insulation between the sections a solid insulator, or paper impregnated with an insulating compound, should be used. Paper alone is not the best insulator, but when impregnated the combination surpasses in insulating qualities either substance by itself. This method furnishes also a most convenient means of supporting the sections of winding a uniform distance from each other. The outside insulation is required for the protection of the secondary winding, and because many coils are worked with a longer spark length than the distance between the two extreme end sections.

If the secondary winding is left open much energy is wasted by the little streamers that brush out into the air, and this loss is greater the higher the potential. Ozone is also generated under these conditions, which deteriorates the insulation between the

secondary turns, and eventually causes a burn-out. The forming of these streamers is best prevented by having the coil immersed in oil; but in most cases the conditions under which the coil is used are such that the sloppiness of oil insulation is a prohibitive disadvantage. Vaseline and other semi-liquid insulators are popular in Europe, while American manufacturers are partial to solid insulators, such as paraffin or a combination of resin with beeswax or other substances. Paraffin alone, though often recommended, is not the best insulator for this purpose.

It is of course of vital import that whatever insulator is chosen should have a high dielectric strength, but K is another factor that should influence the selection. We have shown that an increase in the value of K for the insulating tube will make a difference in the amount of current it will take to charge the coil, and the capacity between the different sections of the secondary adds materially to the total capacity of the coil and the best condition would be, as already suggested, for K to have the same value in each case.

It is most important that all moisture should be driven out of the winding by heating or otherwise before the coil is finally insulated, and Flemming suggests that where oil can be used it should have a higher specific gravity than water, especially if it is to be used in a damp place.

In order to make sure that all the air is driven out, the vacuum system is to be most highly recommended; and for this purpose most of the largest manufacturers have installed vacuum impregnating apparatus.

The method of putting the coil in a box and imbedding it entirely in solid insulation is not to be recommended because of the increased weight and the difficulty of getting at the winding should any repairs become necessary.

THE SECONDARY.

The number of turns and size of wire of the secondary winding will depend upon the spark length desired and the purpose for which the coil is to be used. The theoretical formulæ for the maximum secondary voltage, which determines the spark length are based on so many conditions and approximations not met in actual practice that their application to the specific design of a coil is of little value as compared with practical experience. As we have already mentioned, the "kick-back" voltage of the primary in coils, as usually constructed, has been found to be about twenty times the voltage applied across the terminals, and the maximum voltage of the secondary has a proportionality with the primary "kick-back," viz., the ratio of the number of turns in the two windings. Moreover, the primary "kick-back" and the primary current are proportional up to a certain point. This point is the point of saturation on the magnetization curve and is determined by the amount of iron in the core. We can now appreciate the contention that the rating of a coil should include the amount of current to be used and can see that, for instance, a nine-inch coil designed for three amperes will not be the best where twenty amperes are to be used.

The secondary voltage is directly proportional to the number of turns in the secondary; this is the most important consideration. There should not be a larger number of turns than is required for the spark length in order that the secondary may be kept small, cheap and effective. Of course the longer the spark length the smaller will be the value of the secondary current for a given interrupter and a given amount of primary current.

The number of turns in the standard 12-in. coils now on the market ranges from 50,000 to 80,000, although a spark of over three feet has been obtained with 85,000 turns.

The size of wire is somewhat of a compromise and on this size will depend the strength of the secondary current and the volume of the spark. The small wire has a greater resistance per unit of length, but a shorter length will be required, as it can be more compactly wound. On the other hand, the resistance decreases inversely as the square of the diameter, and a large wire must be used where much energy is needed. Even when merely a certain spark length is required a size smaller than No. 36 is not advisable, and for the maximum size the compromise might be drawn at No. 32, except in the case of a coil built for some special purpose.

We now come to the dimensions of the secondary. The cubic space that this will take up has been pretty well fixed by determining the size of wire and the number of turns, but these and the size of the core could not be definitely designed without reference to the form the secondary will assume; a cut-and-try method being employed for this determination. Perhaps a good proportion for the secondary length would be the same as the distance between the terminals of the secondary, but this may not be practicable in small coils where the drop of potential per turn of primary is less owing to the small amount of iron. Rochefordt and Weidts advise a secondary one-fourth the length of the primary and others one-third the primary length and still others extend it nearly the full distance.

As for the outside diameter of the coil a good ratio for the secondary is three times the core diameter; but this must depend on other considerations.

The secondary may be built long and slender or short with a correspondingly larger diameter, but the latter form will require a longer length of secondary wire. By referring again to Fig. 1 it is seen that the field is strongest at the middle of the core and decreases toward either end. It also decreases as we move away from the core at right angles to its axis. If space and current were of no value use could be made of a much larger amount of iron, only a small section need be employed in the center of this intense field for a comparatively small secondary winding, which would then be most effective and give the maximum voltage and power per turn of winding.

Because of the disposition of the lines of force around the core, the diameter of the secondary is often decreased toward the ends as shown. This is accomplished in the actual coils by a series of steps, which of course means added expense in winding and assembling.

Many makers have wound the outside sections with heavier wire than the inside, not appreciating the fact that, although the potential is greater, the current is the same throughout the whole winding. This is analogous to putting heavier links at the ends of a chain than in the middle. It is a little odd, however, that this old custom should happen to be a good thing in wireless telegraphy where these few end turns may have to withstand high frequency currents. Where separate inductance coils are not used for the purpose, these secondary turns have a big choking effect on high-frequency currents, and they should be especially well insulated from each other.

When there is capacity across the secondary the insulation is overworked, and with a high-speed interrupter the natural period of the circuit may be approached and unwelcome oscillations may be set up in the secondary.

The secondaries of two coils are sometimes run in series to obtain a high potential, but it can be readily demonstrated that the capacity of the two coils as a condenser is greater than would be that of a single coil of the same spark length.

Besides a high potential, a large quantity of current is required in wireless telegraphy and a properly designed 12-in. coil having the same outside dimensions as usually given to a 16-in. coil will handle more energy and give better results than would the ordinary 16-in. or 12-in. coil. Flemming speaks of a 10-in. coil giving less than a quarter inch spark with a capacity of one-eighteenth of a microfarad across the terminals.

Another phase of the importance of the secondary resistance, about which we have said so much, may perhaps be made more apparent by a few statements regarding the "time constant" of a condenser. It is important in wireless work to charge the condensers in the shortest possible time. The product of the condenser capacity in microfarads and the resistance in megohms through which it is charged is known as the time constant; the resistance of the secondary of the coil counting into this resistance. A condenser will be practically charged to the applied voltage at the end of a period which is equal to about ten multiplied by the time constant. By way of illustration Flemming calculates that for a capacity of one mf. charged through a resistance of one megohm by an applied e.m.f. of 100 volts the condenser would be charged to only 63 volts at the end of a second and to 86 volts at the end of two seconds. For a more usual case, a capacity of 1/100 mf. would be practically completely charged through a resistance of 10,000 ohms (1/100 megohm) after the voltage had been applied for 1/1,000 sec., and what this

condition would mean with an electrolytic interrupter can easily be appreciated.

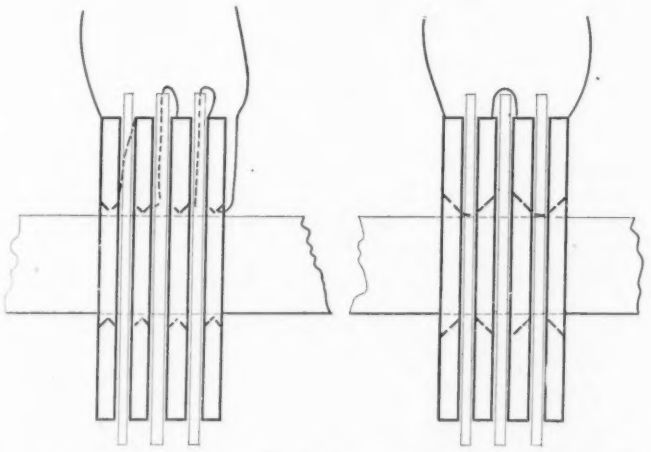
Let us now consider the various methods of winding the secondary.

One way is to wind the wire in layers, the insulation being increased as the difference of potential becomes greater between the layers, and numerous large coils have been wound in this way. The accepted practice, however, is to make this winding in sections or "pies" and then connect and assemble them on the core. The thickness or width of these discs may be an inch or more or the diameter of a single wire; the outside diameter determining the outside dimension of the coil and the inside diameter being large enough to allow it to slip on over the insulating tube. The thicker the pies, the greater must be the insulation between them; the usual thickness is from 1/16 to ¼ in., ⅛ being a good size for coils from six to 16 in. in spark length.

Leslie Miller has invented a machine for winding these in a spiral the thickness of the wire, the first layer being wound from the outside toward the center and the next from the inside outward in the opposite direction and so on, using a single sheet of impregnated paper for insulation between them and making the whole secondary one continuous wire without the necessity of making any soldered connections.

Some makers use thin sections insulated from each other with mica and without other insulation, the windings being open to the air.

There are two ways of connecting the sections together: Either from the inside of the first to the outside of the second and from the inside of this to the outside of the next; or, by



FIGS. 5 AND 6.—METHODS OF INTERCONNECTING THE COILS.

connecting the two insides and the two outsides of succeeding sections. These two methods are shown in the sketches of Figs. 5 and 6.

Where the second method is adopted the coils may be wound in pairs, so that there will be no soldered connection at the inside. This is done by having the winding wire on two spools and revolving one of these with the first coil till it is finished, and then using this second spool for the other coil of the pair.

We see by an inspection of Fig. 6 that there is alternately between the insides and outsides of the sections, twice the difference of potential of a single section, while Fig. 5 shows that there is across any part of two consecutive sections never a greater difference of potential than that generated by a single one of them. Unfortunately this connection cannot be run down on a slant, but because of constructional difficulties it must be run as shown in the last sections, passing down midway between the two, and here we have at both the inside and outside positions of this wire the full potential difference of a single coil with only one-half the thickness of insulation between them. This makes the danger of puncture at these two points as great as in the method shown in Fig. 6, but here the danger is at two single points instead of two lines the full length of the inner or outer circumference of these sections. Unless the coil is to be immersed in oil the insulation between sections should extend beyond the winding in order to prevent the spark from jumping between the sections over the surface of the insulation. This makes the path for the spark over this outside surface greater, but we do not want to waste space in this way at the inside of the sections where there is great danger of sparking along the surface of the insulating tube. We can, however, increase this distance by winding the edges of these coils on a slant as shown.

THE CONDENSER.

This discussion would not be complete without some attention being given to the condenser that bridges the interrupter in the primary circuit; the understanding of which is none too clear. There is an old idea that this condenser absorbs surplus electricity at "make," but a glance at the diagram of Fig. 2 will show that the condenser is short-circuited at this time and can play no part unless it be to spark across the gap, just before contact is made, in giving up a charge left over from the "break." The function of the condenser is to give a more rapid speed of break by preventing or minimizing the arc that would otherwise be drawn between the contacts. There is a best capacity for this condenser as will be seen later.

The optimum capacity, according to Ives, for a given condition of working is that capacity that will give the longest secondary spark and is the least that will cut down sparking at the interrupter near zero. The longest spark is not obtained at the condition of least sparking at the break. For the latter condition we must add more capacity, and when the capacity is greater than the optimum Mizuno has shown that the spark length of the coil is decreased.

The current in the primary circuit which is broken by the interrupter charges the condenser at break, which, according to Walter, as shown in the last curve of Fig. 3, causes across the gap an oscillatory discharge as the contacts separate. His theory is that the higher this rate of oscillation the better, and the smaller the capacity the faster will be this rate, but it requires a capacity at least as large as the optimum to take care of the arc and a larger capacity than this would only use up more current to charge it. Possibly, as Flemming suggests, the current oscillating through the primary may hasten the demagnetization of the core.

Since it is advantageous to build a coil that will require the least capacity let us see upon what factors the optimum capacity will depend. Lord Rayleigh has found that by increasing the speed of break the amount of capacity required is lessened and when the circuit was broken by a bullet from a rifle the longest spark length could be obtained with no condenser at all.

The capacity is also found to vary directly as the inductance of the primary, up to a certain point.

Ives has found that the resistance of the circuit, *a b c d*, of Fig. 2 should be as small as possible; *b* showing the break and *c* the condenser. The capacity increases with the primary current in a ratio greater than the square of the current and less than the cube; this ratio being nearer the square the smaller the resistance of the condenser and interrupter circuits; therefore we see the advantage of keeping the resistance of these leads and connections as low as possible.

Some types of interrupters will work as well without a large capacity, and we will see if we can find a reason for this. The Wehnelt interrupter has very little arcing on small currents and it is a very rapid form of interrupter, and with its high rate of interruption it has also a high speed of break. Moreover it is known that the platinum point and the solution form an electrolytic condenser across the break of comparatively large capacity. We have already called attention to the fact that the secondary spark at make with this interrupter is sometimes very great, but this type possesses a great advantage in the amount of current that it can handle and because it can be run on a commercial lighting circuit.

The mercury interrupter has an extremely low resistance, and besides this, mercury is more or less a non-arcing metal.

In all cases the capacity should be made variable, unless, as seldom happens, the coil is to be run on a constant amount of current under unvarying conditions.

In subsequent articles the practical design and construction of several sizes of coils will be described.

The Single-Phase Induction Motor.—III.

By Alfred Still.

STARTING DEVICES FOR INDUCTION MOTORS.

UNLESS provided with an additional winding or some auxiliary device, a single-phase induction motor will not start from rest. The reason of this has already been explained, but it has also been shown that when once a certain speed has been imparted to the rotor, the latter will continue to run, and will, moreover, revolve at an increasing rate until the maximum possible speed—very nearly equal to that of synchronism—has been attained. It has also been explained that this result is due to the magnetic field created by the magnetizing currents circulating in the closed rotor windings, when the latter are moving through the main inducing field. Now, since this cross flux is exactly 90° out of phase with the main field, it might evidently be produced, in a motor with rotor at rest, by means of auxiliary stator coils, wound in the polar spaces between the main coils, and excited by an e.m.f. from an independent source exactly one-quarter period out of time phase with the e.m.f. across the main stator windings.

Such an addition to the single-phase motor clearly transforms it into a polyphase machine; but all practical single-phase motors are provided with auxiliary starting coils wound on the stator in the space unoccupied by the main windings, and supplied—by means of some more or less effective phase splitting device—with currents differing in phase from the magnetizing currents in the main inducing coils. The object, in all cases, is to provide a cross flux as nearly as possible of the same phase as that produced by the rotor itself, after it has run up to speed, this flux being of the same phase as the currents induced in the short-circuited rotor coils by the pulsations of the main stator flux. The result will be that the rotor currents, by reacting upon this cross field, will produce a torque sufficient to start up the rotor against the various static forces which have to be overcome.

A number of phase-splitting devices, generally external to the motor, have been devised for the purpose of producing a displacement of phase between the currents flowing in the main stator windings and the starting windings, respectively. For very small motors a simple arrangement consists in connecting the main and starting windings in series, but providing a resistance as a shunt across the starting coils. When full speed is attained the latter coils, together with the resistance, are cut out, leaving the main winding directly across the supply. By substituting a condenser for the non-inductive resistance, a better effect is obtained.

In the case of large motors—in which wound rotors are used, having slip rings to permit of resistances being inserted in series with the secondary windings at starting—the main windings are connected directly across the supply, while the starting coils have either a condenser or choking coil in series with them for the purpose of displacing the phase of the current. The resistance in the secondary windings is gradually cut out, and when the speed reaches something under three-quarters of the normal working speed, the circuit through the starting windings is opened.

It is usual to arrange the magnetic axis of the starting coils so that it is displaced 90 electrical space degrees relatively to the magnetic axis of the main stator coils, although in certain Langdon Davies motors and in some of the Wenström motors, a different angular displacement has been adopted, apparently with the object of obtaining, as nearly as possible, the effect of a uniformly rotating magnetic field of constant strength.

The difficulties experienced in producing reasonably large magnetizing forces at anything approaching a phase displacement of 90 time degrees leads to very indifferent results being obtained by any of the methods referred to above. The starting torque is usually only sufficient to run the motor up to speed on a loose pulley, and the current taken from the supply mains is very large, being at least equal to the full load current of the motor. It is not possible to start up against full load.

The following figures refer to some of the earlier machines of the Maschinenfabrik Oerlikon, and are a fair sample of the results obtainable by the use of external phase shifting devices.

In small motors, up to 4 hp, with squirrel-cage rotors and no slip rings, the starting torque would be about one-fifth of full load torque, with a current equal to one and a half times full load current. In larger machines, or in all those provided with wound rotors and collecting rings—permitting of resistances being inserted in series with the secondary windings when starting—a torque equal to about one-third of full load torque would be obtained, with a starting current not exceeding the normal full load current.

HEYLAND SINGLE-PHASE INDUCTION MOTOR.

A great advance in the matter of starting was made when—about seven years ago—Mr. Alex. Heyland brought out his improved motor capable of starting against full load torque with a moderate current consumption. The arrangement of this motor is shown diagrammatically in Fig. 14, which represents the stator of a motor having only one pair of poles.

The working winding is arranged in a number of holes or slots in the usual way, these slots occupying about two-thirds of the inner periphery of the stator core, and being so designed and disposed as to reduce the leakage flux to as small an amount as possible. When connected to the source of supply, this main winding will produce a magnetic field in the direction of the axis, *A'A*. The starting coils—which are cut out of the circuit after the rotor has run up to speed—are wound in rectangular holes provided in the portion of the stator stampings unoccupied by the main windings. Any currents circulating in these coils will produce a magnetic flux through the rotor in the direction of the axis, *B'B*, at

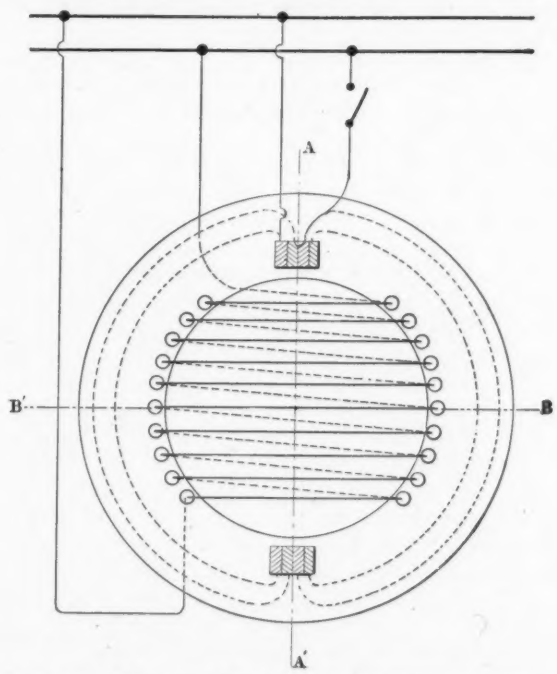


FIG. 14.—HEYLAND SINGLE-PHASE INDUCTION MOTOR.

right angles to *A'A*. The important feature of the Heyland winding is that these starting coils have *few turns* and are of low resistance, the result being that a very strong starting field is obtained, which is limited only by considerations of magnetic saturation. It will be seen that the starting coils are connected directly to the source of supply, and the amount of the cross field produced will, therefore, be inversely proportional to the number of turns in these coils. A much larger starting flux can be obtained in this manner than by means of any external choke coil or condenser provided for the purpose of displacing the phase of the current in the starting winding; and since the starting torque is equal to the product of rotor currents and magnetic flux in phase with these currents, it will be proportional to the product of main and cross fields, provided these differ in time phase by one-quarter of a period. In practice the phase difference between the two fields will not be nearly 90°, but it is claimed for the Heyland motor that the phase displacement is fully 45°, as against about 30° in motors using external choke coils, etc., in series with the starting winding. It follows that, if the starting flux, in the direction B'B, is calculated to be equal to $\sqrt{2}$ (or 1.41) times the main flux in the direction *A'A*, the useful component of the cross field (for a phase angle of 45°) would be equal to the main field

at the moment when the rotor starts from rest, and the starting torque would be comparable with that obtainable in a two-phase motor supplied with two currents equal in amount but differing in phase by a quarter period.

EFFECT OF INCREASING THE SECONDARY RESISTANCE AT STARTING.

In all induction motors, whether single or polyphase, a superior starting torque is obtained by the device of connecting the windings of the rotor to slip rings, and providing a non-inductive resistance which, by this means, can be inserted in series with the secondary windings when running up to speed. Machines with wound rotors will, therefore, behave better at starting than those with rotors of the squirrel-cage type, which are merely provided with conductors permanently short-circuited by means of substantial metal rings at the two ends of the rotor. It must not be overlooked that this latter type of construction is cheaper and generally better mechanically than the wound rotor, and it is, therefore, well to adopt it when possible, as, for instance, when the machine is of comparatively small size. In the Heyland machines, of which the principal feature is a good starting torque, wound rotors and external starting resistances are used even for sizes down to one or two horse-power. It is not economical to provide a squirrel-cage rotor with conductors which shall, at all times, offer a high resistance; because, although such a machine might start well, it would clearly be wasteful of energy under normal running conditions. At the same time, such motors might be used with advantage under special conditions, and for intermittent work, where a high efficiency is not important, and heating troubles are not likely to arise.

The reasons why the effect of increasing the secondary resistance up to a certain limit will result in an improved starting torque may be gathered from the following considerations. The total torque exerted by the rotor may be considered as the sum of the turning moments due to each of the rotor conductors tending to move through the magnetic field in which it is immersed, and the amount of each individual turning moment can be expressed by the product: *current in rotor conductor* × the component of *the magnetic flux* entering the rotor, in the neighborhood of the conductor, *which is in phase with the current passing through the conductor;* thus, although the rotor currents and the flux through the air-gap may be very great, there would be no resultant turning moment if the phase difference between current and magnetic flux were exactly 90°.

It will be remembered that when explaining Fig. 5 (which has been reproduced herewith as Fig. 15), it was shown that the rotational e.m.f. generated in the coils *a*, as they cut through the main flux, N_a, produces the flux N_r, along the axis $B\,B'$ exactly at right angles to $A\,A'$; and also that this cross flux, so obtained, differs in phase from that of the main flux by one-quarter of a complete period. Now, the object of the starting coils—which are not shown in Fig. 15, but which, in the Heyland motor, would lie on the axis $A\,A'$—is to produce a cross flux in the direction $B\,B'$, as nearly as possible of the same time-phase as N_r; that is to say, differing 90° from the phase of the useful component, N_a, of the main flux. It should also be observed that, whatever the value of the cross flux, N_r, which we will now consider as due to the current in the starting coils, this cannot be affected by the currents circulating in the rotor conductors represented by the closed coil, *b*, and similarly the amount of the main flux, N_a, which enters the rotor, is not altered by currents flowing in the closed coil, *a*. But, if the design of the magnetic circuit is such that there is considerable magnetic leakage (and this is invariably the case in an induction motor), heavy rotor currents in such coils as *a* will cause a parge portion of the total flux due to the starting winding to be leakage magnetism, which does not enter the rotor, and, similarly, any considerable currents in *b* will weaken that component (N_a) of the total main flux which passes through the rotor. This effect has already been described when treating of the overload capacity of induction motors, and the curves in Fig. 9 clearly indicate a rapid falling off of the torque after the current has reached a certain value; the reason of this being that, although the rotor current may continue to increase beyond this value, it leads to so large an increase of the leakage field that the product of the rotor current and the useful field entering the rotor begins to decrease in amount.

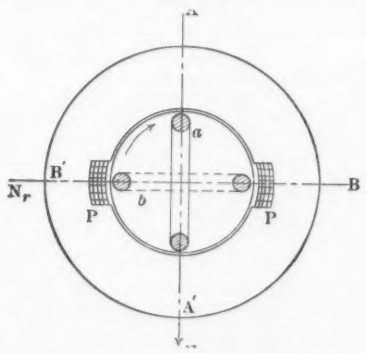


FIG. 15.—ARRANGEMENT OF ROTOR AND STATOR COILS.

Exactly the same effect occurs at starting, and it is for this reason that the insertion of a resistance in series with the rotor windings generally leads to an improved starting torque.

Referring again to Fig. 15, and bearing in mind that N_a stands for the useful main flux which passes through the rotor, while N_r is that portion of the starting flux passing through the rotor, which is in phase with the rotor currents in *b*, and therefore one-quarter period later, as regards phase, than N_a, we may write:

total starting torque = (N_a × *currents in a*) + (N_r × *currents in b*);

but *for a given resistance of rotor windings* (including starting resistance in series, if any), the currents in *a*, with rotor at rest, are clearly proportional to the amount of the flux N_r, while the currents in *b* will proportional to the flux N_a; hence,

$$\text{Starting torque} \propto (N_a \times N_r) + (N_r \times N_a)$$

$$\propto N_a \times N_r.$$

This may be written:

$$\text{Starting torque} \propto N_a \times N_s \sin \alpha,$$

where N_a and N_s stand respectively for the main and starting fluxes *which enter the rotor*, and α is the phase angle by which N_s lags behind N_a.

In the Heyland motor the object is to make the quantity $N_s \sin \alpha$ as large as possible, regardless of the value of N_a, and this will evidently have the effect of producing a large starting torque, although previous designers have generally aimed at obtaining *equal* values for main and starting fields, probably because the rotary field theory—which is sometimes convenient when treating of polyphase motors—has been frequently used for explaining the action of single-phase motors.

ACTUAL STARTING TORQUES OBTAINABLE WITH THE HEYLAND MOTOR.

The Heyland motors are specially designed to meet various conditions arising in practice. Thus some of the earliest motors were capable of exerting full load torque at starting, the current at starting being about twice the normal full load current. Such motors, however, would not give satisfactory results where smaller starting torques would be sufficient, because the current taken from the mains would be out of all proportion to the results obtained. For producing smaller starting torques, motors are specially designed to give two-thirds full load torque with one and a half times full load running current, or to run up light on a loose pulley taking only about four-fifths of full load current. Starting torques greater than full load torque can be obtained with the Heyland motor, and some figures have been published relating to an improved four-pole, 6-hp, 230-volt, 50-cycle motor, which show that a starting torque corresponding to a load of 9 hp at full speed is attainable. For full load torque at starting, the current consumption is 50 amp., being less than double the full load running current, which is 30.5 amp.

All the above figures refer to motors working on circuits of frequencies not exceeding 50; with higher frequencies the performance would not be so good, greater currents being required to produce the same starting torques.

CONCLUSIONS REGARDING THE STARTING OF INDUCTION MOTORS.

Since the starting torque depends largely upon the amount of the magnetic leakage, it is evidently of importance—not only for

the best results in the matter of overload capacity, but also in regard to starting torque—to so arrange the magnetic circuit and the windings as to compel the greater portion of the total flux due to the main stator winding, to pass through the rotor, even when fairly large secondary currents are induced in the latter. It must also be borne in mind that the actual starting torque, with the rotor at rest, may be bad if the rotor happens to be in a position where the leakage field is exceptionally large. This may very well occur for certain relative positions of rotor and stator windings, even when the *average* leakage field is comparatively small; and it is a point which should not be overlooked by the designer.

For the best *running* performance, it is essential that the rotor windings should have a low resistance, not only because this will result in a more constant speed and higher efficiency, but also because the maximum or "break-down" torque is dependent upon the rotor resistance; and a motor having large copper losses in the rotor will not stand so large an overload as the same machine, if rewound with a greater amount of copper. If the reader will refer to Fig. 10, which was drawn to illustrate the connection between torque and speed, he will see that the maximum value of the left-hand curve not only corresponds to a greater slip or lower speed, but its numerical amount is actually less than that of the right-hand curve, which applies to the same motor, but with a rotor resistance of exactly *half* the amount assumed in connection with the left-hand curve. This is a distinctive feature of the single-phase motor, for in a polyphase machine the maximum value of the torque is independent of the rotor resistance. It follows that the use of wound rotors—which provide a low resistance rotor circuit for running, but allow of extra resistance being inserted at starting—is of relatively greater importance in the single-phase than in the polyphase motor.

In order to allow of the cheaper and more mechanical squirrel-cage rotor being used, the suggestion has been made that the stator might be wound in such a manner as to produce twice as many poles at starting as when running. The rotor would be of the squirrel-cage type with high resistance end rings; but low resistance connections would be provided between certain bars or groups of bars, arranged in such a way as to produce good short-circuiting paths under *running* conditions (i. e., with the smaller number of poles), while the currents induced under starting conditions would have to pass through the high resistance end rings. There are many objections to this suggested method, and it is not likely to prove a serious rival to the more usual methods of starting.

Numbers of suggestions have been made from various quarters relating to the starting of single-phase motors, many of which involve the use of a commutator or its equivalent; and, in this connection, it may be well to point out that, with the addition of a commutator, the alternating-current motor may be designed to fulfil almost any condition, not only in respect to starting under load with moderate currents, but also as regards power factor and speed regulation. With the addition of a commutator and a number of brushes, the alternating-current motor not only becomes far more costly to manufacture, but it loses its distinctive feature of mechanical simplicity.

It is doubtful whether the commutator with all its inherent defects, its high cost, and the sparking troubles which are almost certain to accompany its reintroduction, is the correct and final solution of the alternating-current motor problem. It is true that the series traction motor is proving a success, notwithstanding the commutator, but this motor is usually made for large outputs only; moreover, it is generally in the hands of skilled engineers and it works on comparatively *low frequencies*. It is in connection with the smaller motors, suitable for the usual periodicities of lighting circuits, which are frequently in charge of unskilled men, that trouble is to be looked for if the commutator is adopted.

EFFICIENCIES OF COMMERCIAL INDUCTION MOTORS.

The single-phase induction motor, which, as already pointed out, can be compared, in the matter of its chief characteristics and performance, to the direct-current shunt motor, has not such a high efficiency as the latter. Thus, the efficiency of a 5-hp continuous-current shunt machine, by a good maker, might average .84 at full load, and .77 at half load, whereas the corresponding figures for the single-phase induction motor might be .78 and .72, respectively.

The following table may be useful as an indication of the efficiencies and full load power factors obtainable with alternating-current induction motors suitable for working on a frequency of 50; but the figures are approximate only; they represent the average of a number of actual tests, and give a fair idea of what may be expected from a present-day motor; but they will not compare favorably with the performances claimed by many makers for their machines as gathered from their published figures:

Size—H.P.	Efficiency— Full load.	Efficiency— Half load.	Power factor at full load.
5	.78	.72	.78
15	.80	.75	.80
25	.81	.76	.82
50	.82	.79	.85

The results obtained will depend largely on the *frequency*, being best for comparatively low frequencies. The chief advantage of working on circuits of low periodicity is that this permits of higher inductions being used in the iron cores, with a corresponding gain in the performance generally; but especially as regards power factor.

SPEED REGULATION AND CONCLUDING REMARKS.

It has already been pointed out that the induction motor is essentially a constant-speed machine. If the rotor is of the "wound" type, with slip rings, resistances can be inserted in series with the secondary windings, which will lead to a reduction of the speed, since the portion of the total secondary e.m.f. absorbed by the resistances does not require to be balanced by the e.m.f. of rotation in the cross field; but such a method is equivalent to putting a resistance in series with the armature circuit of a direct-current shunt machine, and is very wasteful of energy.

Another method of altering the speed consists in so arranging the windings that the number of poles can be varied, this being usually accomplished by means of a special controller which groups the coils in two or more different ways. By this means a gradual speed variation cannot be obtained; moreover, the motor will only work under the most favorable conditions with a definite number of poles which gives the best flux distribution, and makes the magnetic leakage a minimum.

To obtain satisfactory speed regulation within reasonable limits corresponding to the field regulation of a shunt-wound, direct-current motor, it would be necessary to have some means of gradually altering the frequency of the stator current. There is undoubtedly a demand for a simple form of frequency changer, which shall be low in cost and preferably without moving parts.

Mr. B. G. Lamme has patented a system of variable-speed operation of alternating-current motors, but it would appear to be applicable rather to polyphase than to single-phase induction motors. It introduces the principle of changing the frequency; but since it involves the use of a special rotary converter, driven by a small series motor with commutator, in addition to the induction motor, it would hardly seem to be the final solution of the alternating-current motor problem.

Since the single-phase motor is practically a two-phase machine with one of the phases entirely disconnected; a comparison between the single-phase and the polyphase induction motors is helpful in fixing one's ideas. The chief difference between the two types of machines is that, in the polyphase motor, the cross field, in phase with the rotor currents, is provided by the magnetizing currents in the stator windings, whereas in the single-phase motor it is the secondary e.m.f. due to the rotation of the rotor conductors in the main inducing field, which gives rise to the necessary magnetizing currents required to produce the cross field. If, therefore, we imagine a two-phase motor to have one of the phases disconnected, after the machine has attained full speed and is running without external load, it follows that the current in the remaining stator winding will be approximately double its previous value, because this current must necessarily provide the whole of the power originally divided between the two phases.

Another point of interest is that, if a number of two-phase motors are all running off a two-phase supply, and one of the phases is then entirely disconnected at the generating end, leav-

ing the motors running on a single-phase supply, any one of the motors may be stopped and started again without difficulty, exactly as if it were connected to a polyphase supply. This result, it will be understood, is due to the fact that the other (running) motors provide the magnetizing currents in the stator coils on the second phase, and so produce the necessary cross flux.

In a single-phase induction motor the materials are not so fully utilized as in a polyphase machine; the stator windings do not embrace the whole periphery of the stator stampings, not only because space must be left for the starting coils, but also because there is no advantage to be gained by carrying the windings beyond a certain point on each side of the magnetic axis. For a given load and percentage slip, the I^2R losses in the secondary of a single-phase induction motor will be about double what they would be in a polyphase motor under the same conditions, and the result is that the single-phase machine is, on an average, from 30 to 40 per cent heavier than the equivalent polyphase motor. This is a disadvantage which cannot be overlooked; at the same time, if close attention is paid to the matter, improvements in this respect may be expected in the future. A comparison between figures relating to polyphase induction motors will show a very considerable gain in the matter of weight per horse-power of output between the motors of to-day and those built only a few years ago.

New Telephone Patents.

REPEATER CIRCUIT.

The repeater problem has not rested alone on the design of a repeating apparatus, but also in the provision of a non-humming circuit. That is to say, that a circuit is necessary such that a repeater will work from either direction and yet will repeat forward only so that there will be no reflection of the magnified current upon the receiving line. A Wheatstone bridge circuit provides the necessary relation if the incoming and outgoing lines be substantially alike in properties, and substantially balanced

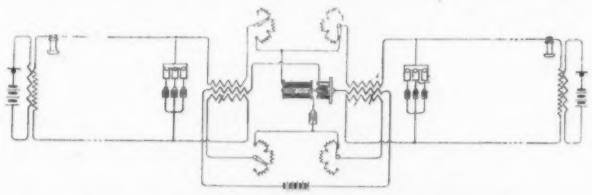


FIG. 1.—SHREVE TELEPHONE REPEATER CIRCUIT.

as to their own limbs. H. E. Schreve, of Newton, Mass., has patented such a circuit, with adjusters for both the resistance and capacity of the four line limbs involved. Fig. 1 shows his circuit. The American Telephone & Telegraph Company has been assigned Mr. Shreve's patent.

SWITCHBOARD CIRCUITS.

The two-wire circuit system for common-battery systems is still well represented at the Patent Office and patents are being continually issued covering various modifications. Mr. A. Stromberg, of Chicago, has devised a system in which the battery supply is continually connected to the subscriber's line, a line relay being in the live side and a cut-off relay in the ground side. The cut-off relay will not work in series with the line relay, and thus does not disturb the line signal. When a plug is inserted in a jack, however, the supervisory relays are thrown in shunt with the line relay and provide a current path in which the cut-off relay operates to obliterate the line signal. The supervisory signal system is the usual double-control system with a primary cut-in control relay and a secondary back contact control relay. The Stromberg-Carlson Company has been assigned the patent for this system.

Another system, the patents for which are assigned to the same company, has been invented by H. G. Webster. In this system the cut-off relay is double-wound and so connected to its own contacts that one of its windings is always short-circuited. One side of the subscriber's line is connected to both windings of the cut-off relay. In calling up, one of these is not in circuit and the second is short-circuited. Upon the response of the operator the plug supplies current to the second winding of the relay, whereupon it operates, short-circuiting its second winding and at the same time clearing the first.

Still a third system of this type involves two double-wound relays, each with one of its windings in each side of the line. One relay is connected cumulatively and makes a contact, while the other is differential and breaks a contact. The line lamp circuit includes both contacts. Upon a call up, when the same current flows in both line limbs, the cumulative relay operates to light the lamp, the differential relay failing. When a plug is inserted a secondary current supply is given one line limb so that the differential relay becomes unbalanced and operates to cut off the lamp. This system is patented by J. G. Roberts, of Evanston, the patent being assigned to the Western Electric Company.

For common battery systems the question of potential is largely one of happy medium, for the lower the battery the lower the transmission; and the higher the battery the worse the clicks. Two batteries may, of course, be used, one for signaling and one for talking. H. G. Webster has worked out and patented a two-wire system on this plan, his patent being assigned to the Kellogg Company.

RECEIVER.

Fig. 2 shows a receiver patented by C. T. Mason, of Sumter, S. C., the novelty in which lies in the metal cup piece, which

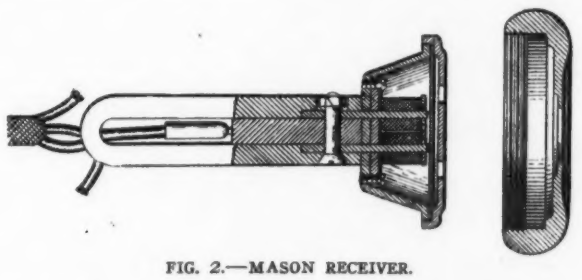


FIG. 2.—MASON RECEIVER.

clamps the diaphragm to the magnetic system. This is supplemental to the ear cup and performs the clamping function independently of it.

SELECTIVE SYSTEM.

W. R. Whitemore has patented a six-party selective system in which a special bell is used. This bell has two cores parallel to each other with a yoke across both ends. Two auxiliary pole pieces arise from the middles of the yokes and approach the armature, which latter is pivoted at the middle of one core. This core is wound in two sections. In order to operate a bell the poles must be forced upon the auxiliary pole pieces, and six distinctive combinations may be arranged by the proper connection of the three coils between the two sides of the line and ground.

To M. H. Degnan, of Nashua, N. H., must be credited a very odd selective device of the step-by-step class. The escape wheel shaft carries a cam, the roller of which is secured to a tilting box. This box has a long zig-zag track in which a metal ball runs. Each cam has a notch and as the roller passes it the ball starts to travel the slot. If the cam takes another step the ball runs back home. If, however, the cam stops the ball makes its full travel and closes the ringing circuit of its station.

TELL-TALE.

A tell-tale to indicate a call has been invented by B. L. Stone and G. M. Dressel, of Belpre, Ohio. This is a shutter device controlled by a trigger engaging the bell clapper. The shutter may be set by hand. If a call comes the disturbance of the bell clapper releases the trigger and the indicator falls.

AUTOMATIC SYSTEM.

An automatic system for a large number of subscribers without the use of auxiliary selectors has been devised by G. A. Betulander, of Stockholm, Sweden. His scheme provides a series of mechanisms each riding upon the other and partaking of all its motions. Thus one digit is set upon one rider, and while these relations are maintained the second is moved upon its guides on the third, etc., until all the digits are set and the connection established.

Letter to the Editors.

Wireless Telegraph Receiver.

To the Editors of Electrical World:

Sirs:—In his letter printed in your issue of December 8 Prof. Fleming has done me the injustice of expressing an opinion based on an extract only of my paper regarding the "Audion." In a more complete abstract of that paper in the *Electrician* of London it is seen that I mention not only the device described by Prof. Fleming in 1904, but point out the real genesis of this device by Elster and Geitel in 1882, or eight years prior to its rediscovery by Prof. Fleming in 1890. The German investigators were at that early date demonstrating the remarkable unidirectional quality of a gas at low pressure when the cathode is an incandescent wire or filament, and illustrated the exact device employed subsequently by Prof. Fleming and myself. However, the figure illustrated in your abstract of my paper clearly shows the local battery in the telephone circuit, which makes all the difference between a possible rectifier of alternating currents of very considerable voltage and a relay or trigger device, whereby the flow of the local current is affected to an extraordinary degree. In one case we have merely a rectifier with a direct-current motor (the galvanometer), which is thus actuated by the energy of the rectified received oscillations themselves—an effect apparent with intensely strong impulses only. The "Audion" on the other hand when properly connected in a tuning circuit, shows a sensitiveness at least ten to thirty per cent greater than that of the electrolytic receiver using the finest Wollaston anode.

The difference which Prof. Fleming questions may be tersely stated as that between a few yards and a few hundreds of miles; between a laboratory curiosity and an astonishingly efficient wireless receiver employing the same medium, but operating on a principle different in kind. The differences in the actual phenomena involved in the Elster-Geitel tube and the Audion I have described at some length in my paper.

I have been unable to obtain any sign of rectification of high-frequency currents with the device unless their potentials exceed 20 or 30 volts—potentials which, of course, are impossible at wireless telegraph receiving stations. In the Wehnelt incandescent cathode valve or rectifying tube (disclosed, by the way, in 1903,) this lower voltage limit to complete rectification is observed. In the "Audion," however, especially in the "bi-wing" type, where the oscillations are applied to an independent electrode, there is the exact opposite of the rectification effect observed in a direct-current instrument in series with the battery in the local circuit. When only tolerably strong signals are received, the galvanometer deflection is *reduced,* and that frequently to one-third or one-half its normal throw.

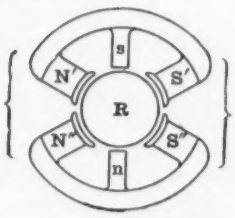
Prof. Fleming is further in error in stating that electrolytic rectifiers do not show unilateral conductivity for high-frequency currents. The well-known discoveries of Prof. Pupin in that field in 1899 surely require no rehearsal. In fact, it is in this very particular—that of rectification of Hertzian oscillations of comparatively small potentials—that the Pupin electrolytic valve far exceeds in efficiency that of the Elster-Geitel-Wehnelt-Fleming vacuum oscillation valve.

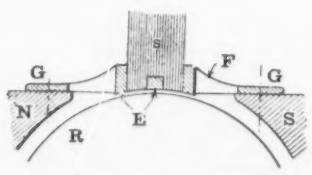
New York. Lee de Forest.

DIGEST OF CURRENT ELECTRICAL LITERATURE

Dynamos, Motors and Transformers.

Direct-Current Machine with Commutating Poles.—Fynn.—A description of a new type of direct-current machine with commutating poles. A special feature is that the field structure has main poles divided into magnetically independent or nearly independent units. One type of construction is shown in Fig. 1,





FIGS. 1 AND 2.—DIRECT-CURRENT MACHINE WITH COMMUTATING POLES.

in which *n s* are the interpoles and $N'N''$ and $S'S''$ are the divided main poles. It is claimed that in consequence of this construction a very much smaller amount of copper is needed on the commutating poles, and that the distortion of the main field will be very much smaller, resulting in a very much smaller tendency to flashing and in better proportionality between load and commutating flux, thus insuring almost perfect commutation throughout. Other descriptions based on the same principle are also described and illustrated. Another device used in connection with this design, as shown in Fig. 2, consists of what may be described as a copper pole shoe surrounding the auxiliary pole, *s*, and forming, preferably, two short-circuited coils, such as *E*, disposed in closest proximity to the armature periphery. These coils tend to keep the commutating flux constant, in spite of the periodic variation in the reluctance of its magnetic circuit, and which is brought about by the motion of the slotted armature. These short-circuits also tend to reduce the self-induction of the coils undergoing commutation. When provided with ribs, *F*, and lugs, *G*, fixed to the adjacent main poles, these copper pole shoes can be made use of to prevent any possible vibration in case the auxiliary poles have to be made of laminations or when their thickness is mechanically insufficient.—Lond. *Elec.*, November 30.

Selection and Testing of Materials for Machines.—Epstein.—The first part of a paper read before the British Institution of Electrical Engineers. The author deals especially with the selection and testing of the iron and steel used in dynamo-electric machinery. In general the higher the permeability and the higher the point of saturation, the better is the iron. "It is important in comparing the materials and factors of safety to refer to the right

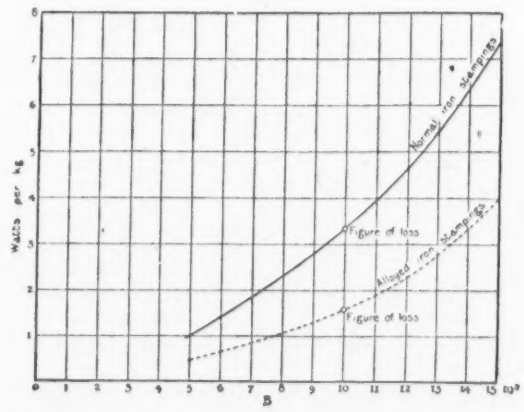


FIG. 3.—COMPARATIVE PERMEABILITY CURVES.

factor. In investigating the permeability of ordinary cast iron the author would recommend, as a characteristic figure, to take the number of ampere-turns per centimeter required for $B = 9{,}000$, and as regards special steel, those required for $B = 17{,}000$. "As to hysteresis and eddy-current losses, German practice now uses as a characteristic figure the loss measured at 50 cycles with $B = 10{,}000$ lines per square centimeter. In the German rules this value is called the "figure of loss" (verlustziffer). The adoption of this standard has proved very useful during the last few years. Since the eddy currents decrease with rising temperature, the figure of loss is determined for a standard temperature of 30° C. A comparison of the old with the new kind of iron sheets is shown in Fig. 3. The curves are plotted for 50 cycles, and the lower one is that for a modern sheet of special alloy, while the upper curve represents a sheet which was until

lately considered as being of first-rate quality. Ageing is defined by the German rules for iron as the percentage variation of the figure of loss caused by keeping the sample at a temperature of 100° for more than 600 hours. There is no difficulty in obtaining ordinary stampings, whose ageing will be within a maximum of 15 per cent. The importance of testing most carefully mica tubes for high-tension machinery cannot be too much emphasized. In the Felten-Guilleaume-Lahmeyer laboratory every mica tube is tested up to at least double the working pressure, the tube being covered with tin-foil and filled with metal rods and the heating effect of the dielectric hysteresis is noted under the same conditions. Their standard practice is to fill up the tubes with iron rods and to cover them in such a way that the exposed portion of the tubes equals 20 per cent of the length under test.—Lond. *Elec.*, November 30.

Design Coefficients.—HOBART AND ELLIS.—In the concluding article of their serial on design coefficients for dynamo-electric machines, they discuss the output coefficient of alternators, and the total weight coefficient of polyphase alternators, various diagrams being given from practice.—Lond. *Elec. Rev.*, November 30.

Power.

Storage of Water.—GOLWIG.—The author first explains the great importance of the storage of water in hydraulic systems in which the amount of available water varies. The storage may be either natural or artificial. In the case of natural storage, the water is simply held back in a basin at its upper level, while in the case of artificial storage the water is raised by pumps into a basin at a higher level, and the potential energy is won back later with the aid of high-pressure turbines. The chief disadvantage of such methods of storing in practice is a legal one because people who live along the water course below its lower level and who have a legal right to use this water, will object to the water being artificially held back in the storage basin. However, this disadvantage can be overcome by providing two basins, one at the higher level and one at the lower level, both being provided with automatic regulation devices, by means of which the flow of the water out of the lower basin is made equal in every moment to the inflow of water into the upper basin. The application of this principle is illustrated by diagrams.—*Elek. u. Masch.*, December 2.

French Water Power Stations.—MONTPELLIER.—A statistical article on electric stations in the Jura district which contains 87 towns with public electric distributing systems, isolated plants not being counted in. The electricity is generated in 27 power stations of which 17 supply only one locality, while the other ten transmit energy to other towns. Of the 27 stations, 14 use direct current, three single-phase current and ten use three-phase currents. In 23 of the 27 stations, the electrical energy is generated from water power. All the ten stations which have transmitting systems use alternating current.—*L'Electricien*, December 1.

Analyzing Gas in Steam Plants.—KERSHAW.—A continuation of his illustrated serial on gas analysis for steam users. In the present installment the author describes two typical methods for determining the proportion of carbon dioxide in the gases.—Lond. *Elec.*, November 30.

Producer Gas.—NAGEL.—A continuation of his serial on the theory of producer gas. In the present installment he deals with mixed distillation and combustion gases.—*Electrochem. and Met. Industry*, December.

Induced Draft.—CASMEY.—A paper dealing with the unsatisfactory results of imperfect combustion of coal, and with the improvements which can be obtained by using fans for induced draft.—Lond. *Elec. Eng.*, November 30.

Electro-Physics and Magnetism.

Power Factor.—GANZ.—A Franklin Institute paper on the physical meaning of power factor, and the significance of a power factor less than unity without phase difference. Power factor, as defined by the ratio of true to apparent watts, is in general less than unity, and can never have a value greater than unity. In circuits with distorted alternating e.m.f. and current waves the power factor is determined by two components: first, the angles of phase difference between synchronous harmonic components of e.m.f. and current (as determined from Fourier's series), and, secondly, by the variation from proportionality of the harmonic components of the waves. With irregular wave shapes the phase position is sometimes measured from the zero points of the waves and sometimes from the maximum points; the latter has the disadvantage that the maximum point is not well defined, and that some waves have more than one maximum point. The phase difference between irregular waves of alternating current and e.m.f., as measured between their zero points, does not bear a direct relation either to the power or to the power factor of the circuit. Two irregular waves may be in phase; that is, cross the time axis at the same points, and yet cause a low power factor. Similarly two irregular waves may be considerably out of phase; that is, cross the time axis at different points some distance apart, and yet the power factor may be greater than the cosine of this angle of phase difference between the irregular waves. The reason for this lies in the fact that certain harmonics alter the wave shapes near the zero points of the irregular waves so that these zero points of the irregular waves are shifted considerably from the zero points of their fundamental sine components, and the latter are generally the principal elements which determine the power and power factor. The ordinary alternating-current arc is a good example of distorted e.m.f. and current in phase, and yet having a low power factor. In the special case of a sinusoidal electromotive force and distorted current, which is of frequent occurrence in practice, the power factor is the product of two factors, one factor being the cosine of the angle of phase difference between the fundamental sine wave of current (as determined from Fourier's series) and the electromotive force, and the second factor being the ratio of the effective value of this fundamental sine wave of current to the effective value of the distorted current wave. If the power factor of a circuit is low on account of phase difference between current and e.m.f. it is possible to raise the power factor to unity by connecting a suitable reactance or a synchronous machine in shunt with the circuit. If the power factor is low on account of wave distortion, it cannot be raised by shunted reactance. If the power factor of a circuit is low both on account of phase difference and of wave distortion it can be corrected by shunted reactance only for that part which is due to phase difference.—*Jour. of Franklin Inst.*, December.

Resistance in a Magnetic Field.—GRUNMACH.—Measurements concerning the change of resistance experienced by metals in a magnetic field have hitherto been fully carried through only as regards bismuth. Such measurements are of profound significance with regard to the theory of conduction in metals. The author examined the behavior of 16 different metals in fields ranging from 2,000 to 16,000 units. The results show that the metals may be arranged in two groups one containing the paramagnetic and diamagnetic metals and the other containing the ferromagnetic metals. In the first group the resistance increases with the transverse magnetization. Of the ferromagnetic metals, nickel and cobalt show a decrease, but in the case of most specimens of iron and also to a slight extent in nickel, the diminution is preceded by an increase of the resistance in the weaker fields.—Lond. *Elec.*, November 30.

Calculation of Electromagnets.—EMDE.—The first part of a mathematical paper in which the author first discusses in detail all physical relations which are of importance in the calculation of electromagnets. He then makes applications to engineering practice.—*Elek. u. Masch.*, December 2.

Electro-Chemistry and Batteries.

Production of Sodium.—CARRIER.—The conclusion of his illustrated article in which he gives a complete review of the different processes which have been proposed or used in practice for the extraction of metallic sodium. In the present installment the author discusses the electrolysis of fused sodium carbonate, of fused sodium hydroxide, of fused sodium nitrate, and processes using compound electrolysis; i. e., a cell with two electrolytes connected by a bipolar electrode (in this case fused lead). The author finally refers briefly to electrolysis of solutions, and deals at some length with sodium alloys. His chief conclusions are that all the attempts to produce sodium commercially have failed except those involving the direct electrolysis of fused caustic soda (Castner process). The only important use of the lead-sodium alloy is in the production of caustic soda. For further improvement the only hope seems to be

in the electrolysis of fused salt, the field where the greatest number of failures have been recorded. It is quite probable that a successful solution of the problem has been found in the Ashcroft compound process. At the present price of sodium it seems probable that its use will still be confined to the preparation of sodium cyanide, sodium peroxide and a few minor applications, but it is to be hoped that the price may be further reduced and new uses found.—*Electrochem. and Met. Industry,* December.

Platinized Platinum Anodes for Chlorate Production.—Geibel. In the electrolysis of sodium and potassium chlorides platinized platinum anodes are not yet used commercially, although Foerster found that not only the voltage at the same is lower by 0.5 or 0.6 volt than at polished platinum electrodes, but that the ampere-hour efficiency in the production of hypochlorites and chlorates is thereby considerably increased. The chief reason why platinized platinum electrodes have not found favor in practice is that they were not durable. From experiments made by the author it appears that if the platinum-black layer on the electrode is transformed into platinum-gray by careful heating, the layer sticks firmly to the electrode and the latter is sufficiently durable for use in practice. At the same time the platinum-gray electrode gives about the same increase of efficiency over the polished plate as can be obtained with platinum-black. The transformation of platinum-black into platinum-gray is best carried out in an electric furnace, the temperature of which may be exactly controlled. Since it is important that the effective surface be as large as possible, the heating temperature should not be too high.—*Electrochem. and Met. Industry,* December; from *Zeit. f. Electrochemie.,* November 9.

Colloids.—Malcolm.—An account of experiments on double refraction in colloids produced by electric endosmosis.—*Phil. Mag.,* December.

Units, Measurements and Instruments.

Measuring Speed Irregularities.—In the operation of two alternators in parallel, it is important to know the maximum difference in the phases of the voltages of the two machines. A method devised by Huldschiner for this purpose is as follows, the arrangement being shown in Fig. 4. In order to avoid all

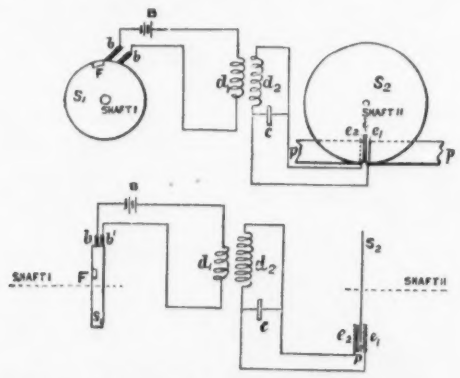


FIG. 4.—MEASURING SPEED IRREGULARITIES.

pen friction, the record is made by means of an electric spark passing through a sheet of paper. On the spindle of one of the two alternators a brass contact disc, s_1, is mounted, with a small piece of fibre, *f*, let in at one point of its periphery. On this disc two brushes, *bb*, rub, and, normally close the primary circuit of a small induction coil, $d_1 d_2$. For an instant in every revolution when the brush comes to a piece of fibre, this circuit is interrupted, and at this instant, consequently, a spark is produced between the secondary terminals of the induction coil. These secondary coils are formed of two thin brass strips, e_1 e_2, separated by the recording paper, *p*, and by an insulation (paraffined cardboard) disc, s_2, attached to the shaft of the second alternator. This disc is pierced by a specially shaped slot, *i*, inclined to the radius of the disc, and it is through this slot (at a height depending on the relative positions of the slot, and the strips, *e*, at the instant when the circuit is broken at *b*) that the recording spark passes. If the paper is drawn past the strips by hand a continuous record will be produced by the action of the successive sparks. Supposing the two alternators are running exactly synchronously, the discs will always occupy the same relative positions at the instants when the brushes, *bb*, cause the sparks to pass, and the record will be a straight horizontal line. If, however, hunting is taking place the instants at which the circuit is broken by disc, s_1, will correspond with various positions of disc, s_2, and so various points of the inclined slot will be opposite the strips, e_1, e_2, and the successive sparks will pass at different heights, and form a wavy curve. The shape and slope of the slot in disc, s_2, is of importance. The less the deviation from the direction of a radius the more sensitive will the arrangement be. In practice the disc, s_1, is provided with several slots of various slopes, and representing various ranges of measurement. By moving the brushes *bb* round disc s_1, any desired one of these slots can be brought into action.—Lond. *Elec'l Rev.,* November 30.

Thermo-Electric Pyrometer.—White.—An article in which the author shows that the thermo-element may be made an instrument of precision, comparable with the best thermometers of other types, if proper precaution is taken. The main errors which result in changes of the thermo-element are due to inhomogeneity. If the latter is removed, in most cases far greater accuracy may be attained. The author deals specially with the platinum-rhodium and with the constantan-copper couples. Constantan and copper wires are apt to become chemically inhomogeneous through the formation of a film of oxide or other tarnish. Cleaning off this film nearly restores the original calibration. Platinum in an oxidizing atmosphere absorbs vapors of rhodium and irridium. These contaminating impurities cannot be removed, but can be excluded by enclosure in glazed porcelain tubes. Thermo-elements of platinum-rhodium and of constantan-copper when used with proper precautions are free from any error as great as 0.005 per cent. With platinum this amounts to less than one-twentieth of a degree at 1,000° C. With constantan it amounts to less than 0.002 per cent for measurements up to 40° C.—*Phys. Rev.,* December.

Automatic Interrupter.—Ries.—Two thin round rods of carbon are placed parallel to each other at a distance of about 1 centimeter and are connected to the two terminals of a storage battery, giving about 8 volts. A third carbon rod is placed across the two and upon the same. Under these circumstances the two contact points between the three carbons show sparks and a distinct sound is heard. This proves that periodic processes must occur. If now the primary winding of an induction coil is connected to the circuit, sparks appear quickly after one another between the terminals of the secondary. The apparatus with the three carbon rods therefore represents an automatic interrupter. If the third rod which is placed on the first two is so shifted that it almost rests entirely on one of the other two, and makes only a very loose contact with the second one, sparks appear only at this loose contact and the sound has a much higher pitch, the frequency of the sparks in the secondary being greatly increased.—*Phys. Zeit.,* December 1.

Comparison of Capacities.—Trowbridge and Taylor.—A note in which the authors describe a new circuit for the comparison of capacities and of inductances, which is more nearly free from errors due to distributed capacity than is the regular Maxwell bridge. Within the limit of error, that is one ten-thousandth, the authors have established that the ratio of the capacities of two good mica condensers is the same, whether compared by direct or by alternating currents, providing that proper precautions be taken to eliminate the effect of absorption. Distributed capacity in high-grade resistance boxes whose coils have brass cores causes a serious error in alternating current measurements; but this error may be much reduced by using boxes whose coils are wound on wooden cores.—*Phys. Rev.,* December.

Miscellaneous.

Standardization.—Glazebrook.—His presidential address to the (British) Institution of Electrical Engineers. After reviewing the progress made in international agreements concerning fundamental units, the author refers to a recent report of the Screw Threads and Limit Gauges Committee as an example of the work done by the Engineering Standards Committee. First, some definitions are given: "Tolerance is a difference in dimensions prescribed in order to tolerate unavoidable imperfections of workmanship. Allowance is a difference in dimensions

prescribed in order to allow of various qualities to fit. Clearance is a difference in dimensions or in the shape of the surface prescribed in order that two surfaces or parts of surfaces may be clear of one another." The committee then collected numerous data on the tolerances and allowances actually found in typical machine shops. On this basis the committee standardized limits of workmanship, since it was enabled to suggest limits which would be practicable and which are actually being worked to in leading shops.—Lond. *Elec.*, November 16.

BOOK REVIEW.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Twenty-ninth Convention Proceedings, Etc. Three volumes. New York: James Kempster Printing Company. 662, 576, 240 pages. Illustrated.

The increasing activity of the National Electric Light Association is indicated by the growing size of its annual publication, which the present year is issued in three volumes. Volume I comprises the papers and reports presented at the Atlantic City Convention and the discussions thereon. Volume II is given up to the "Question Box," and Volume III contains the voluminous report of Mr. Gardiner on the "London Sliding Scale" and the reports of the Committees on Rates and Costs, and on Theft of Current. The latter volume is only issued to members in Class A, comprising central station companies.

A notable characteristic of the Atlantic City Convention programme was the small representation of commercial "write-up" papers. While not entirely absent, the few papers of that class presented are above the average of some years in the past, when the plenitude of such contributions and their perfunctory character served to dampen interest in the sessions and detracted from the value of the annual publication. The papers which doubtless will give the report the greatest permanent value are those of Mr. Paul Spencer on line construction, and Mr. E. M. Hewlett on modern switchboard practice. Excellent papers on electrical engineering questions of the hour were presented by Mr. L. B. Marks, on the flaming arc lamp; Mr. W. S. Barstow, on the mercury arc rectifier system and magnetite lamps; Mr. W. N. Dickinson, Jr., on alternating-current elevators; Mr. Sydney Hosmer, on grounding secondaries, and Mr. John Meyer, on mechanical refrigeration. To the central station manager, however, the greatest value of the volumes will lie in the very large amount of matter relating to the business side of the central station. The numerous papers on business getting and other subjects connected with the dollars and cents' side of central station work, though necessarily of rather ephemereal character, will probably find an interested reader in almost every member of the Association. While it is most gratifying to note the increasing attention given by the Association to this class of papers, this encouragement might be extended to providing more time for their discussion, even if the result should be the shortening of the convention programme by a half-score of papers.

The Atlantic City "Question Box" appears to have been somewhat more carefully edited than in past years, as the answers to queries are less contradictory and more to the point. Instead of printing replies practically identical, a single one is selected and accompanied with a footnote stating that practically concurrent opinions were expressed by others whose names are given. In not a few cases the inquirer should have been referred to easily accessible books as, for example, when he asks for an explanation, with diagram, of the two-phase, three-phase transformer connection, or the manner of determining the pressure on the crosshead guides of a horizontal engine, or a statement of the principles of the barometric condenser. On the whole, however, the "Question Box" is of the highest value to members of the Association, and while containing a certain number of queries that should not be asked by intelligent men, and involving much repetition from year to year, we cannot agree with a suggestion of the editor that it might perhaps with benefit be superseded by a handbook subject to revision every five years. One defect of the "Question Box" which should be remedied is the lack of guidance in cases where there is conflict or considerable variance of opinion in the answers. In the case of action of apparatus and instruments, such differences might be referred to experts of the manufacturers for comment, and in the case of an engineering question the answers might similarly be submitted for comment to an engineer who is an authority on the subject. This, however, would be impracticable unless the editor were allowed more time for his work than in the past. In view of the hasty manner in which it is compiled, the "Question Box" as printed is highly creditable to the editor notwithstanding its defects.

The Plant of the American Spiral Pipe Works, Chicago.

The increasing use of metallic pipe in all departments of hydraulic and hydro-electric engineering has given a tremendous impetus to the manufacture of a kind of pipe which will possess all the strength and durability of solid cast-iron or wrought-iron pipe but have greater lightness. In many hydraulic conveying systems the diameter of pipe required is often so great that the solid pipe would be very expensive to lay on account of its weight, and especially so on account of the inaccessibility of the section of country traversed by the pipe line.

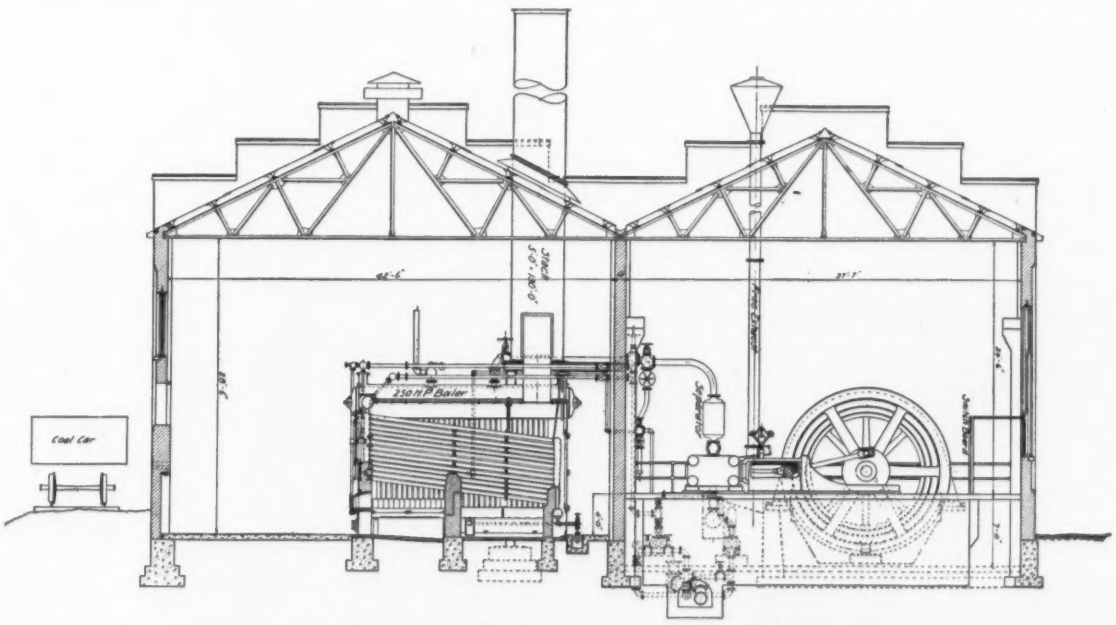


FIG. 1.—CROSS-SECTIONAL VIEW OF POWER HOUSE.

Within the past year the American Spiral Pipe Works, the

pioneer manufacturer of spiral pipe in this country, has constructed a very extensive and modernly equipped plant covering 20 acres, between 46th and 48th Avenues, south of 14th Street, in Chicago, near the suburbs of the city. The plant is the largest in this country manufacturing spiral pipe, and has a capacity of one mile of pipe per day, ranging from 3 to 40 in. in diameter. Nearly 2,000 tons of steel are carried in reserve for "rush" orders.

The principal or pipe shop building is constructed of brick and steel and is typical of the best practice in mill construction. The roof is of the saw-tooth type and affords ample light for the manufacturing operations. In this building is manufactured riveted pipe and heavy sheet metal material. The building adjoining the pipe shop is a material storage shed, built of steel, for housing raw material. The buildings immediately above the pipe shop are the galvanizing and asphalting plants and the testing room, in which the design is such that the completed product may be tested and given a galvanized or asphalt coating on its way from the shop to the shipping room. The forge shop, machine shop, stock room and shipping room are parallel

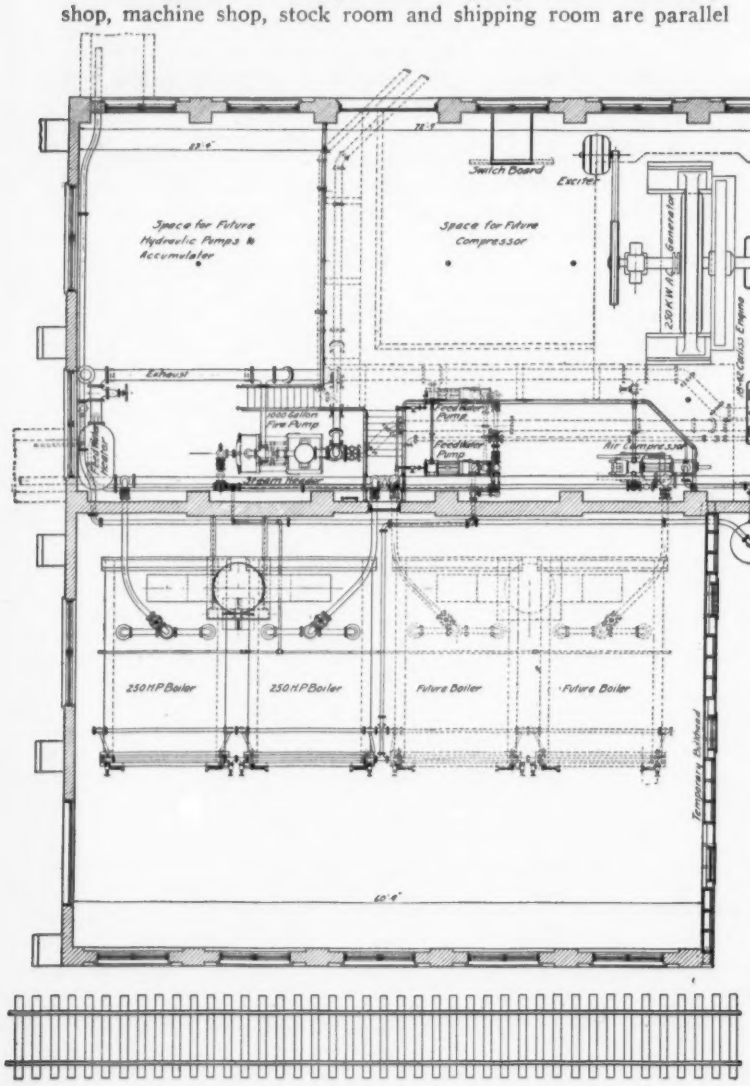


FIG. 2.—PLAN OF POWER HOUSE.

to the main building and hard by, and are of similar construction. In the forge shop, in which forged and rolled steel flanges are made entirely, there are a number of special heavy machines for making drop forgings from 10 to 400 pounds in weight.

The office building is a two-story brick structure at the entrance to the plant and is 90 ft. long by 40 ft. wide.

The construction of the power house building is similar to the main building with the exception of the eastern end which is of wood to allow for future enlargements. The floors and machinery foundations are concrete and the structure is covered with a corrugated, galvanized iron roof, asbestos lined. In Figs. 1 and 2 is shown the general arrangement of the power house machinery and apparatus. Fig. 3 shows the boiler room which measures 60x40 ft. The south wall contains coal doors through which coal is supplied from a track alongside. A coal bunker is to be constructed shortly.

The boiler room is of special interest. It is equipped with two 300-hp Munoz internally-fired, high-pressure, sectional water-tube boilers. The boilers are normally worked at 120 lb. steam pressure and were tested at 240 lb. pressure without showing any flaw. The boilers embody the highest advance thus far made in the art of steam generation and possess very novel and exclusive features. The drums and cross-boxes are so arranged that they form an arch of inclined tubes over the furnace. The placing of these tubes inside the vertical center of the steam drums permits a line of 4-in. vertical tubes to be expanded into the steam drums immediately at the center of the tubes. The latter tubes have 6-in. centers and completely enclose the boiler, and are connected at the bottom with a 12-in. side drum. Since the greatest amount of steam generated in a water-tube boiler is in this portion of tubes directly under the fire, this arrangement of tubes brings the maximum heating surface nearest the fire.

The setting or casing of the boilers is a 4-in. tile arranged directly against the 4-in. vertical tubes. These tubes by absorbing the heat, prevent the tile from being heated higher than the boiler water. These tiles are placed one on top of the other without the use of fire clay or mortar; twelve tiles are used per section. The sections are banked up and the joints broken by asbestos fire felt two inches thick. This is then encased by steel plate panels weighing from 60 to 75 pounds each, which are maintained in position by easily removable clamps. Thus the entire boiler is surrounded by a solid steel framework which greatly reduces the radiation of heat and splendidly adapts the boiler for taking care of the widely fluctuating steam requirements incident to the operation of steam hammers and forging machines. Such method of support also gives exceptionally fine and quick access to all pressure parts of the boiler for inspection, cleaning or repair. The individual, self-contained setting of the boilers with 4-ft. alley between greatly conduces to high efficiency and economy of operation. On each boiler there are eight blow-off points—four on each side for blowing or cleaning out soot in the tubes, so arranged that it is very easy to maintain the boiler free from dirt at all times. The boilers are equipped with Dorrence shaking grates.

The products of combustion from each boiler are conducted through steel breeching to a steel stack placed between the boilers. The stack rests on a cast-iron plate supported by a steel structure. The stack is 5 ft. in diameter and 130 ft. high. There is installed temporarily in the portion of the plant assigned for future boilers, a water-gas generator with a capacity of 5,000 cu. ft. per hour. The water gas is employed for special annealing and forging work in the forge shop.

The high-pressure steam piping is encased in 85 per cent magnesia sectional covering and is equipped with forged steel flanges made by the pipe works. The exhaust and water main piping—about 2,500 ft. in length—is entirely spiral riveted and is furnished by the pipe works. All high pressure piping valves and auxiliaries were made by the Pittsburg Valve & Construction Company.

All roof drainage is conducted to a concrete reservoir of 150,000 gal. capacity, located opposite the power house. The bottom of the reservoir is lined with a porous tile so that surface water from the neighborhood seeping into the earth will also collect in the reservoir. When the reservoir supply is out the city mains are tapped for boiler feed water.

In Fig. 4 is shown the engine room which measures 72x38 ft. with floor elevated 4 ft. above the boiler room floor. A pump chamber runs along the partition wall with a floor 7 ft. below the engine floor. In this pit is installed a 1,000-gal. Buffalo fire pump, two 500-hp Gardner boiler feed pumps, a Laidlaw-Dunn-Gordon air compressor and a 1,200-hp Stilwell feed water heater of the open type. Ample space is provided for the future installing of hydraulic pumps and an accumulator. The engine is an 18x42 Corliss made by Filer & Stowell, and is direct-

connected to a 250-kw, 100-r.p.m., 220-volt, 60-cycle, three-phase generator made by the National Brake & Electric Company, of Milwaukee, Wisconsin.

The alternator is of symmetrical lines with fine operating characteristics. A special feature of this machine, which contributes very largely to low operating temperatures, is the use of widely separated pole pieces, which construction requires a spider of large diameter, and prevents crowding of the coils; thus the coils have a large radiating surface. The method of bolting the pole pieces to the rim of the spider gives unusual accessibility to any portion of the armature or field winding. The bearings of this machine are of very generous size, which gives a large wearing and radiating surface; they are babbitt-lined, and are made with a sufficient number of grooves and oil rings to give uniform lubrication throughout the entire length of the bearing. The collector rings are built up on a separate skeleton type spider, which gives them splendid ventilation. The rings are cast iron, and fitted with carbon brushes, so that wear and attention are reduced to a minimum. The generators are excited with current from a 160-volt exciter, which is belted to the shaft of the engine. When the plant was started up, the alternator was operated with 85 per cent overload for two hours without showing any excessive increase in the temperature of its windings.

The current for power and lighting is distributed by a two-panel switchboard made of black slate, constructed by the Western Electric Company. The panels measure 24x90 in. each, and each is divided into two sections. The leads from the generator are conducted to the board in vitrified tile ducts in the floor. In these leads as well as all feeder leads, three-pole, double-coil circuit-breakers are inserted, the breakers being placed directly on the board. The instrument equipment is entirely Westinghouse, of the flush mounted type.

Current for lighting and power service is distributed through cables to slate panel boards enclosed in steel cabinets lined with slate located in the different buildings. There are four panel boards for controlling all power circuits in the plant, each of which is located at a central point in a building. Branch circuits are run from the panel boards to the motors overhead. All wiring is entirely open; the insulators are screwed to wooden cleats which are bolted to the lower chords of the roof trusses. All feeder, lighting and branch circuits are protected by non-arcing fuses. There are a dozen lighting panels which receive current from the power panels, and are very similar to the

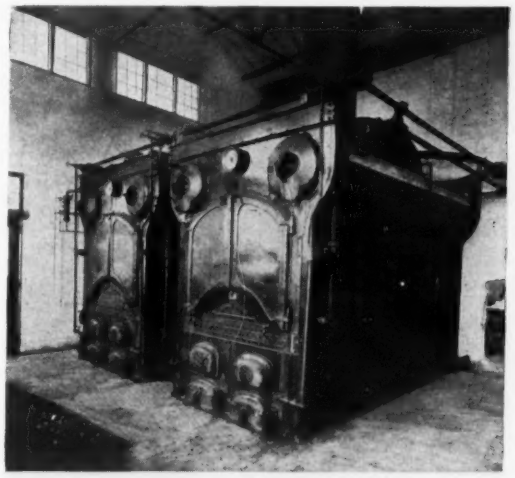


FIG. 3.—BOILER ROOM.

latter. All branch circuits are run two wire and are controlled by 10-ampere double-pole knife switches.

Practically all machinery in the plant is driven by electric motors nearby, all of which are mounted on brackets supported either on the columns or walls of the buildings. All motors are of the induction type and range in size from 1 to 30 hp at 250 volts. The individual driving of machines is employed, although the group drive is used wherever practicable. In the pipe shop there are 36 motors which drive bending rolls, riveting machines, shearing machines, etc. In the forge shop there are four motors ranging from 10 to 20 hp. The motors are about equally divided between the National Brake & Electric Company, the Westinghouse and General Electric companies. All the motors have unusually high efficiency for such small outputs and have given splendid satisfaction. They are started by compensators of the oil-insulated type.

The lighting of the buildings is almost entirely by Cooper Hewitt mercury arcs, one tube generally being used for each group of machines.

The architectural features of the plant were designed by Mr.

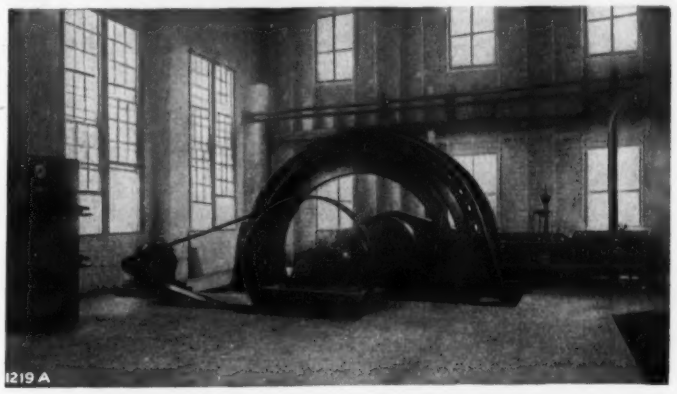


FIG. 4.—ENGINE ROOM.

Wm. T. Branitzky, consulting mill architect, Chicago, Ill. The steam power plant and all mechanical and electrical features were designed by the Arnold Company, consulting and contracting engineers, 181 La Salle Street, Chicago, Ill., the entire construction being supervised by Mr. J. Hall-Taylor, vice-president and general manager of the American Spiral Pipe Works, to whom we are indebted for much information on the plant.

Sixty-Five Mile Interurban Line in Texas.

The Texas Traction Company is equipping a 65-mile electric road between Dallas and Sherman, Texas. The new line will parallel the existing steam road between the two cities and will be one of the longest electric roads in the State. The country, through which it is laid out, is flat and rolling, there being no grades exceeding 1 per cent, with a maximum curvature of three degrees. A private right-of-way has been established by the company, so that the trip between Dallas and Sherman will be made in 2 hours and 30 minutes. This schedule includes a 15 minute run within the city limits of Dallas at lower speeds. While the main traffic will be of an express nature, stops have been provided about every two miles to take care of the local travel.

Fifteen car equipments will be provided to maintain the initiative schedule. These will be of the standard interurban type, 50 ft. long, each equipped with four 75-hp standard direct-current motors equipped with the Sprague-General Electric system of multiple unit control. Each car will be further provided with air brakes and compressors. Power for the new road will be generated by steam at McKinney, midway between Dallas and Sherman. The main power station equipment will include two 1,000-kw Curtis steam turbo-generators working under a steam pressure of 150 lb. at the throttle with 125° superheat. The turbines will operate condensing.

All of the electricity produced for transmission will be generated at 2,200 volts and 25 cycles and stepped up for transmission to 19,100 volts. For exciting the fields two 35-kw generator sets will be provided. The three-phase current from each of the turbo-generators will be transformed in a set of three 330-kw air-blast transformers, one transformer of the same capacity being installed as a reserve. To supply air for cooling, duplicate blower sets will be furnished, one set being driven by an induction motor, the other by a direct-current motor. Each blower will have a capacity of 10,000 cu. ft. of air per hour.

One of the special features of interest in the new road lies

in the rotary converter equipment. Six sub-stations will be provided, including one at the main station and a portable equipment. This last-mentioned sub-station comprises a special car containing a 300-kw rotary converter, air-blast transformers and suitable switching apparatus for cutting into the transmission system wherever necessary. Regular sub-station equipments are to be provided at the main station and at four points along the railroad. Each sub-station will be equipped with a 300-kw, 600-volt rotary converter with the necessary switchboards, oil-cooled transformers and lightning arresters. The sub-stations will be interconnected by high-tension transmission lines, operated initially at 19,100 volts. Eventually, however, a transmission potential of 33,000 volts will probably be used and for this purpose taps will be provided for Y connection of the transformers. The whole equipment is being furnished by the General Electric Company.

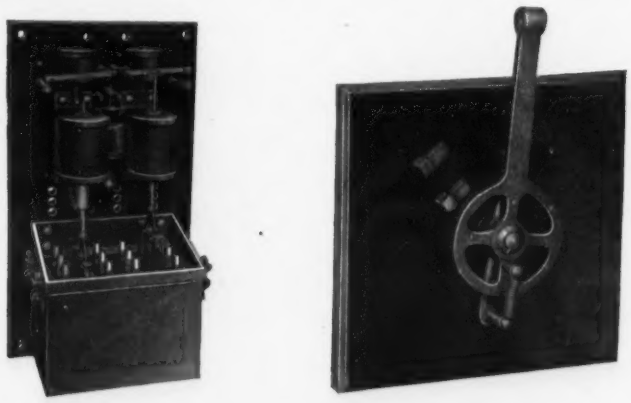
Automatic Starter for Induction Motors.

The automatic starting compensator illustrated herewith is intended especially for use in pumping and similar work. The starter consists essentially of an auto-transformer with two oil-immersed switches, the starting and running positions of which are controlled by two solenoid magnets, interconected by a time-limit relay device. One solenoid switch connects the motor to the auto-transformer or compensator, while the second solenoid connects the motor directly on the line. The time allowed for the motor to come up to speed between the two operations is adjustable by means of a dash-pot auxiliary switch. An interlocking device prevents the two solenoid switches being closed at the same time. The motor is started by closing a small push button switch.

The arrangement of these various parts is shown in Fig. 1. At the left is the solenoid operating the compensator switch; at the right the solenoid which throws the motor directly on the line, while the relay switch is mounted in the center.

The feature which contributes most to the successful operation of the device is the arrangement of the main solenoid switches by which the operating circuits are broken when the solenoid core is drawn up into the closed position. The cores as they rise trip a switch in their energizing circuits so that the solenoid coils do not remain in the circuit. Each core is held in the closed position by means of a detent controlled by a small auxiliary solenoid, which when energized serves merely to hold the core up, floating in its magnetic flux. When the motor is running the only coil energized is this small auxiliary solenoid, which controls the detent of the line switch solenoid.

Thus all operating circuits except the main line switch and the one small solenoid are open, and there is no disagreeable humming or energy wasted in auxiliary circuits. The solenoids



FIGS. 1 AND 2.—AUTOMATIC INDUCTION MOTOR-STARTER.

are all wound for single-phase so that they can be operated from one leg in the circuit.

In starting up a motor a small push button switch is closed, energizing the left-hand solenoid, which throws the compensator into circuit. At the same time the auxiliary relay switch is lifting its core against the retarding action of the dash-pot, and after an adjustable interval of time this switch disconnects the starting solenoid, energizes the right-hand solenoid and thus throws the motor directly on the line. When the motor is running the compensator is cut entirely out of the circuit.

To stop the motor the push button switch is opened, the small auxiliary solenoid core falls on the detent, thus disconnecting the line switch and leaving all spool circuits opened until the push button switch is again closed. Failure of current acts in the same way as opening the push button switch.

This automatic compensator can be supplied where the remote starting and stopping of three-phase induction motors is necessary. In pumping the push button switch may be replaced by a float or pressure switch. In the first case a single-pole float switch can be used, and when the water is to be controlled by pressure a governor, similar to that employed in air-brake work, can be substituted for the push button switch. These are but two of the many ways of applying the automatic compensator which will suggest themselves.

The automatic compensators described are built for circuits employing a potential up to 550 volts. For circuits operating at higher potentials the manufacturers, the General Electric Company, Schenectady, N. Y., provides a series transformer to step down the voltage for the energizing coils. The compensator coils are provided with the usual taps for adjustment to various starting conditions. External enclosed switches are used in the circuit when the motor is across the running side of the compensator switch.

Corner Drill for Wiremen.

The accompanying illustration gives a clear idea of the general design of a special tool devised for drilling in close quarters, and particularly in corners. The spindle is driven by compressed air

FIG. 1.—EXTERNAL VIEW OF CORNER DRILL.

through the medium of gears, thus insuring steady and constant spindle movement.

The tool weighs only 35 lbs. It is designed for driving a 1.5-in. drill (but in emergency cases it will drive a 2-in. twist drill with very satisfactory results); the spindle speed when running

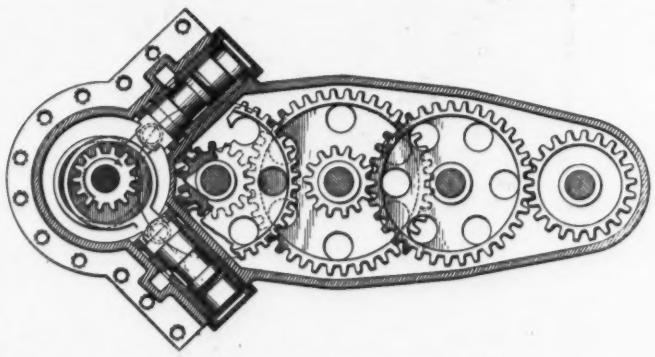


FIG. 2.—SECTIONAL VIEW OF CORNER DRILL.

light is 150 r.p.m.; under load with 80 lbs. air pressure, 100 r.p.m.; distance from end of socket to end of feed screw when run down, 5⅞ in.; length of feed, 2 in.; distance from center of spindle to outside of housing, 1 5/16 in. This device is manufactured by the Chicago Pneumatic Tool Company, Chicago, Ill.

Industrial and Commercial News

Commercial Intelligence.

THE WEEK IN TRADE.—Holiday business engages the most attention at the present time, although there is a steady gain in distribution of winter goods as the temperature becomes more seasonable. General business, which is of enormous proportions, bids fair to eclipse previous records, a significant feature being the demand for high-grade goods. Jobbing and wholesale lines display a slight falling off, but only by contrast with the activity prevailing early in the season. Some irregularity is still noted in collections, which is attributed to high money rates or failure to market the crops. Complaints about freight blockades are numerous, one shipper at the south stating that hundreds of tons of pig iron have not yet started, although the cars were loaded in October. It is alleged that the railways are diverting rolling stock from grain to other higher revenue-paying freight. The situation has become so serious, especially as to coal, that the Federal authorities have taken cognizance of it, and President Roosevelt has requested the Interstate Commerce Commission to investigate the matter. Railway gross earnings in November advanced only 4.6 per cent over the same month in 1905, but in that period traffic was exceptionally heavy and earnings increased 9.1 per cent over November, 1904, when the gain over the like month of 1903 was 9.9 per cent. New business in steel rails is in fair proportions. A foreign contract calling for 30,000 tons of steel pipe has been placed in the United States. The demand for structural material is only fair, but mills appear to be confident of future orders. Coal is in good demand, while coke is scarce and high in price, the car shortage curtailing deliveries. Copper is higher. Only three producers of importance have any lake, electrolytic or casting for first quarter proffers. Prime lake for February and March is 23½ to 23¾c.; electrolytic for the same months is 23¼ to 23½c.; prime casting stock, 60 days, 23 to 23½c. The business failures for the week ending December 13, as reported by *Bradstreet's*, numbered 220, against 216 in the previous week, and 226 in the corresponding week last year.

FRANK B. COOK, CHICAGO, has received many orders for complete outside equipment, or pole cable terminals, for various exchanges, as well as a large number of orders for distributing frames and switchboard protectors. A few of the largest orders he has received for these various types of apparatus follow; the majority of them are for the complete equipment: La Compagnie de Telephone de Bellechasse, Levis, P. Q., complete terminal equipment for Rimonski, P. Q., Canada; Marion & Northern Telephone Company, Clintonville, Wis.; Ohio & Mississippi Valley Telephone Company, for their exchange at Anna, Ill; also for their exchange at Carbondale, Ill.; Farmington Telephone Company, Farmington, Mo.; Tazewell County Telephone Company, Morton, Ill.; Commercial Electrical Supply Company, St. Louis, Mo., for the Home Enterprise Telephone Company, Woodworth, O. T.; the Pinckneyville Telephone Company, Pinckneyville, Ill.; Sullivan Telephone Company, Sullivan, Ind.; the Portsmouth Telephone Company, Portsmouth, O.; the York County Telephone Company, York, Neb.; Little Rock Telephone Company, Little Rock, Ark.; Stromberg-Carlson Telephone Manufacturing Company, for the Farmers' Telephone Company, Everett, Wash. These comprise only the largest orders for terminals that Mr. Cook received. For Type L distributing frame and switchboard protectors, including the No. 8, No. 10 and No. 14 type. Mr. Cook has received orders from the following: Dean Electric Company for the Statesville Telephone Company, Statesville, N. Y.; E. H. Martin Telephone Company, Webster City, Ia.; American Automatic Telephone Company, Rochester, N. Y., for the Home Telephone Company Exchange, Ironton, O.; Sullivan Telephone Company, Sullivan, Ind.; Dean Electric Company for Farmers' & Merchants' Telephone Company, Odessa, Mo.; National Telephone & Telegraph Company, Wheeling, W. Va.; Citizens' Telephone Company, Grand Rapids, Mich., an addition of 1,000 pairs of main distributing frame; Stromberg-Carlson Telephone Manufacturing Company, for the Bristol Telephone Company, Bristol, Tenn.; also an addition of 4,800 pairs for the exchange of the Tri-State Telephone & Telegraph Company, Minneapolis, Minn., south branch; North Electric Company, for Conneaut Telephone Company, Conneaut, O.; Chicago Electric Protective Company, Chicago. For subscribers' station protectors, either Types B-4, B-5 or B-6, the following orders have been received: Wabash Valley Telephone Company, Paris, Ill.; Citizens' Independent Telephone Company, Terre Haute, Ind.; Brockport Telephone Company, Brockport, N. Y.; United Telelphone & Telegraph Company, Philadelphia, Pa.; Independent Telephone Company, Council Bluffs, Ia.; People's Telephone Company, Superior, Wis, and Georgia Telephone & Telegraph Company, Savannah, Ga. Mr. Cook has also received a great many large orders on his self-welding wire joints, universal guy clamps and the Cook clip.

MOTORS FOR FIRE SERVICE.—The equipment for the new Gansevoort and Oliver Street stations of the Borough of Manhattan, comprising ten Allis-Chalmers multi-stage, centrifugal pumps, each with a capacity of 3,000 gallons per minute, will be driven by ten Allis-Chalmers induction motors of 800 hp each, which are being supplied in accordance with the specifications of the Department of Water Supply, Gas & Electricity. These motors will deliver 800 hp at a speed of approximately 73.5 r.p.m. at full load. They are designed for 25-cycle current, supplied at a terminal pressure of 6,300 volts. The motors are wound for four poles, thus giving a speed of approximately 750 r.p.m. at no load. In order to limit the current at starting and at the same time secure large starting torque, the secondary current is regulated by means of an external resistance inserted in the secondary winding. Leads from the three collector rings will connect to suitable controllers located behind the switchboard, there being one controller with its resistance for each motor. At starting, all the resistance is in series with the rotor winding, and as the motor comes up to speed, the resistance is cut out by means of the controller. A suitable switch is arranged on the motor in connection with the collector rings, whereby the latter can be short-circuited after the motor has been started, thus avoiding all current in collector rings and brushes during regular operation. The starting resistance is made of cast iron grids mounted in a substantial cast iron frame and thoroughly insulated. Each motor when running at full speed and supplied with current at 6,300 volts, will develop not less than 800 hp. The efficiency will be not less than 92 per cent at full load. The stations in which these pumps and motors will be installed are identical in every way, and for the present are laid out to accommodate eight pumping units, the piping being so arranged that it will only be necessary to remove the blank flanges from the tees to make the present arrangement of piping suitable for the operation of a total of ten units.

LIGHT AND POWER IN IDAHO.—The Moscow Electric Light & Power Company has just completed its transmission line from Moscow to Pullman, Wash., having just bought the electric plant from the city of Pullman, and is now giving continuous service there. This company has also recently purchased or installed new plants in the towns of Genesee, Idaho, Palouse, Garfield, Tekoa, Oakesdale, Farmington and Belmont, Wash., and have a plant under construction at Rosalia, Wash. The electrical energy for these towns is furnished to the Moscow Electric Light & Power Company by the Washington Water Power Company, who have installed a 60,000-volt transmission line from Spokane, Wash., to Palouse, Wash., and from the Lewiston-Clarkston Company, whose line is 50 miles in length from Asotin to Pullman, Wash., and operates at 22,500 volts. This latter system will be extended to the towns of Uniontown and Colton, Wash., during the coming year, which will give continuous electric service in all the Inland Empire towns, from Spokane to Asotin, Wash. M. J. Shields is president and E. S. Aldrich, general manager, of the Moscow Elictric Light & Power Company.

ALLIS-CHALMERS OUTPUT.—The unfilled business on the books of the Allis-Chalmers Co. is now in the neighborhood of $13,000,000. The earnings of the company, as a result of increased capacity and the growth in the demand for electrical and mechanical equipment, in the current fiscal year will show a very marked increase over the demand for the preceding year.

PLANT FOR MEXICO.—U. S. Consul-General A. L. M. Gottschalk reports from Mexico City that E. L. Doheny, Albert Canfield and Norman Bridge have been given a concession by the Mexican Government for the manufacture of combustible gas from oil, with a base of asphalt, for heating purposes, the same to be distributed through the City of Mexico by means of mains and individual branch lines. The three concessionaires have been prominent in asphalt and petroleum work at Ebano (near Tampico), where they have extensive asphalt properties. The contract embodies the establishment of a factory or gas plant in the City of Mexico, upon which they are to spend not less than $249,000 United States currency. Within six months the erection of the buildings is to be begun. Within ten years the entire installation of the underground pipes to be used in connection with the work must be completed. The concessionaires may establish other gas plants at various points in the Republic, upon the approbation of the Department of Fomento, each of which is to cost not less than $49,800 United States currency. As a guarantee of good faith, the company has deposited $1,490 United States currency in bonds of the consolidated debt with the Department of Fomento, which sum shall be returned to them upon the fulfillment of the contract. The concessionaires are accorded the importation free of duty of all necessary material, machinery, etc., as well as for the electric installation necessary for the lighting of their plants.

ALLIS-CHALMERS ENGINES.—As a result of a steady increase in the business of its Milwaukee plant, brought about by the present heavy demand in the West for leather of all descriptions, the American Hide & Leather Company finds itself in need of additional power for the tannery owned and operated by it in that city. It has therefore contracted with Allis-Chalmers Company to furnish one of the latter's horizontal Corliss engines of the well-known "Heavy Duty" type, which will be belted to line shafting and capable of supplying 500 horse power at its normal capacity. The foundation of the engine already in operation at the American Hide & Leather Company's power house will be enlarged to accommodate the new engine, and the wheel pit will be widened, the compact form of the Allis-Chalmers "Heavy Duty" engine rendering it possible for the purchaser to get along with very little additional space for this installation. The Midvale Steel Company, of Philadelphia, has ordered from Allis-Chalmers Company a heavy-duty cross-compound engine, with cylinder 30 and 46 by 48 inches, for direct-connection to an electric generator, to be installed in its plant at Nicetown, Pa. As this unit will be subjected to extreme overloads during its ordinary operation, the engine is required to be very strongly built. The engine is to be operated non-condensing, and the normal capacity of the unit will be 1,000 kw.

GEORGIA WATER POWER.—It is stated that Boston capitalists have undertaken the harnessing of the falls of the Chattahoochee River, between Columbus and West Point, developing over 200,000 hp, involving an outlay of millions of dollars. The project is now being pushed forward by the Columbus Power Company, a combination of all the power companies along the river for twenty miles above Columbus, Ga. That city is at the foot of the falls of the Chattahoochee River, the course of which for thirty-four miles above is marked by a series of the heaviest falls in the South. There are at present three dams between Columbus and West Point, all of which are within the city limits of Columbus and furnish power to many manufacturing enterprises. It is now proposed to line the river for twenty miles with factories by building dam after dam, as fast as additional power is called for. A water power plant, located at Lover's Leap Falls, is now equipped to supply 10,000 hp, with six water-wheels, each under a head of 40 feet. At this plant, which is but a few hundred yards from the site selected for the new dam, there is a dam 975 feet long and 44 feet wide. A large steam plant also supplies power for present needs.

TWO INDUCED DRAFT FANS of exceptional dimensions are being built for the power station of the East St. Louis & Suburban Railway Company, by the Green Fuel Economizer Company, of Matteawan, N. Y. The wheels of the fans, which are overhung—that is, are supported from one side only—measure 19 feet 6 inches in diameter and 7 feet wide at the tips of the blades. They are believed to be the largest overhung induced draft wheels ever built and will be driven by Corliss engines. They are carried upon 10-inch steel shafts and have specially designed, two-part spool hubs which occupy comparativly little space on the shafts and permit the bearings to be set in close to the centers of gravity of the wheels. Each water-cooled bearing, by the way, weighs over a ton and is considerably larger than many of the planing mill exhauster fans built by this firm. The housings are of sheet steel and are of the "three-quarter" type. They are supported by 8-inch by 8-inch foot rails, ⅝ inch thick.

EXPORTS OF COPPER.—So far in the present year the exports of copper from the United States since the first of the current year approximated 436,150,400 pounds, comparing with about 497,000,000 pounds for the corresponding period in 1905. Total exports of the metal as compiled by the United States department of commerce and labor were 534,900,000 pounds in the twelve months of 1905. Thus in a period covering a little more than two weeks (the latter part of December, 1905), the exports totalled 37,000,000 pounds which compares quite favorably with some of the best months this year. At the present rate of exports December's total will approximate 35,000,000 pounds, bringing the year's figures up to the 445,000,000 pound mark.

THE FAR EAST ELECTRICAL COMPANY, Macao, China, has in hand several projects which will require electrical machinery, and would be glad to hear from manufacturers who could supply their needs. One of these involves the substitution of electric power for steam in a cement plant. The requirements are a 400-hp gas engine using a gas of low thermal quality, an electrical generator and a number of motors. The conditions are continuous operation with a stop once a week only for cleaning and repairs. Gas producers will also be required. Another project is for changing a wood-working establishment to electric power. The current available is 3,000-115 volts, 50 cycles, three-phase.

PLANT FOR NORWAY.—For the information of American exporters of electrical machinery, U. S. Consul B. M. Rasmusen, of Stavanger, Norway, reports that the city council of Haugesund, Norway, at a recent meeting voted 305,000 kroner ($81,740) for the erection of an electric light plant. The city of Stavanger has a similar project under consideration, and the engineering department has completed the plan for the construction of a large power and light plant. More than the required number of subscribers have been secured, and the plant will in all probability be built next year. All correspondence relative thereto may be directed to "Formandskobet" of the respective cities.

MECHANICAL DRAFT CONTRACTS.—Mechanical draft installations of apparatus furnished by the B. F. Sturtevant Company, of Boston, Mass., are being made by Chicago Water Works, 68th Street Station, Chicago, Ill.; People's Gas & Electric Company, Burlington, Iowa; Tabor Glove Co., Milwaukee, Wis.; Northwestern Manufacturing Company, Fort Atkinson, Wis.; Watertown Electric Company, Watertown, N. Y.; Lewis Batting Company, Walpole, Mass.; Wm. M. Barrell Company, Lawrence, Mass.; American Electrical Works, Phillipsdale, R. I., and American Locomotive Company, Dunkirk, N. Y.

ELECTRICITY AT MANILA.—The operating department of J. G. White & Company reports the earnings of the Manila Electric Railroad & Lighting Corporation, for November, by cable from Manila, as follows: Railway and Lighting Departments.—Gross receipts, $76,000; net receipts, $36,600. The net receipts from the lighting business have shown a steady increase since the old lighting plant of La Electricista was supplanted by the new station in August. The earnings of the railway department reflect the continued and regular use of the street railway by the natives.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, manufacturer of the Chloride accumulator, has installed four of the eight sub-station batteries contracted for by the New York Central & Hudson River R. R. Co. for use in connection with the electrification of the New York terminal. The batteries now in operation are located respectively at Bronx Park, Kings Bridge, Mott Haven and Fiftieth Street. The eight sub-station batteries will have a total capacity of 60,000 hp. One of the two exciter batteries contracted for by the same company has also been installed at Port Morris.

MINING IN MONTANA.—The Barnes-King Development Company is behind a plan to build an electric road from Lewistown to the mines, a distance of twenty-one miles. The road will go by the way of the Gebo coal mines. The Boston and Montana Company is making arrangements to install an electric tramming system in its mines. Five electric locomotives have been ordered.

THE MUNSON LINE has arranged to equip its new steamer *Prince George* with wireless telegraphy. The *Prince George* will be operated on the Mobile and Havana route, beginning January 1, 1907. The De Forest system will be installed.

POWER IN MINING.—The Dominion Copper Company is increasing its equipment. On the first of December the use of electrical power was begun throughout the smelter and within sixty days electricity will be installed throughout the mine. A saving of about $100,000 a year should result in the change from steam to electric power. The Cascade and West Kootenay power companies are furnishing the Dominion Company with its electricity at a reduction in cost per horse-power amounting to about $100.

CANADIAN WHITE CONTRACT.—The Canadian White Co., Montreal, has been awarded the contract for building the Union Electric Railroad station at Montreal for the Cataract Power & Traction Co. Price, $225,000.

Financial Intelligence.

THE WEEK IN WALL STREET.—Stock prices were irregular and speculation was nervous during the week, chiefly owing to threatened opposition by the Minnesota Attorney-General to the $60,000,000 new Great Northern stock issue. This news offset the "rights" allotted the stockholders, but the further relief given by the Treasury to the money market tended to check declining tendencies in the general list. In other respects the market presented little evidence of any bullish activity, and interest on the part of the public was of the slenderest description, despite the general recovery at the end of the week. Some attention was paid to United States Steel common, which was notably firm, and various other iron and steel stocks, including Colorado Fuel, were the objects of buying. The traction group was weak on the announcement that the legality of the Metropolitan-Interborough merger was to be tested in court. The extreme firmness of the copper market had its effect upon copper stocks, including Amalgamated and the more prominent curb issues. There was comparatively little business done in electric stocks and no marked changes are noted. After the payment of the dividend, General Electric dropped to 157¼ and closed at 160, this being a trifle lower than the last previous quotation. Westinghouse lost 3 points on the week's business, the opening price being 154 and the closing quotation 151. There was a speculative demand for Brooklyn Rapid Transit, which made a net gain of 2⅞ points, the closing price being 82. The curb market in the main followed the lead of the exchange list, but there were one or two exceptions. Greene Copper developed unexpected strength early in the week, and before the close was rising sharply. Nipissing broke to 12, but regained some of the loss and was at 15 at the end of the week. Copper stocks were in more favor, superseding in a measure the Cobalt shares. The steady rise in the metal has given zest to the trading in coppers. The miscellaneous list was neglected. The above are the closing quotations of Dec. 18.

NEW YORK

	Dec. 11	Dec. 18		Dec. 11	Dec. 18
Allis-Chalmers Co.	17⅛	16⅜	General Electric	161½	158
Allis-Chalmers Co. pfd.	45	43¾	Hudson River Tel.	...	...
American Dist. Tel	25	25	Interborough Rap. Tran.	...	...
American Locomotive	71⅜	71	Mackay Cos.	72¾	71
American Locomotive pfd.	110½	110	Mackay Cos. pfd.	68⅜	67½
American Tel. & Cable	87½	85	Marconi Tel	...	...
American Tel & Tel.	..	...	Metropolitan St. Ry.	...	...
Brooklyn Rapid Transit	81¼	79⅝	N. Y. & N. J. Tel.	...	...
Electric Boat	27	30	Western Union Tel.	86	85
Electric Boat pfd.	70	70	Westinghouse com.	153	148
Electric Vehicle	...	...	Westinghouse pfd.	...	...
Electric Vehicle pfd	...	...			

BOSTON

	Dec 11	Dec. 18		Dec. 11	Dec. 18
American Tel & Tel	136¾	136	Mass. Elec. Ry. pfd	69¼	69
Cumberland Telephone	...	...	Mexican Telephone	...	...
Edison Elec. Illum.	...	...	New England Telephone	...	128
General Electric	...	...	Western Tel & Tel	...	9
Mass. Elec. Ry.	20	...	Western Tel. & Tel. pfd.	89	..

PHILADELPHIA

	Dec. 11	Dec. 18		Dec. 11	Dec. 18
American Railways	51	51	Phila. Electric	8⅛	8
Elec. Co. of America	11⅛	11¼	Phila. Rapid Trans	23⅛	22¾
Elec. Storage Battery	69	68	Phila. Traction	...	96¼
Elec. Storage Battery pfd.	...	...			

CHICAGO

	Dec. 11	Dec. 18		Dec. 11	Dec. 18
Chicago City Ry.	160	160	National Carbon	85	85
Chicago Edison	...	...	National Carbon pfd.	115	115
Chicago Subway	50	44	Union Traction	...	...
Chicago Tel. Co.	115	...	Union Traction pfd.	...	...
Metropolitan Elev com.	26¾	26½			

DIVIDENDS.—The directors of the Cincinnati Gas & Electric Co. have declared the regular quarterly dividend of 1⅛ per cent, payable Jan. 1. The directors of the Spokane & Inland Empire Railroad Company have declared a dividend of $1.25 per share on the preferred stock, payable Jan. 20. Directors of the Maryland Electric Railways Co. have declared an initial semi-annual dividend of 1½ per cent. Directors of the Canadian Westinghouse Co. (Ltd.) have declared the regular quarterly dividend of 1½ per cent, payable Jan. 2. The directors of the Westinghouse Air Brake Co. have declared the regular quarterly dividend of 2½ per cent and an extra dividend of 2½ per cent, payable Jan. 10. The Westinghouse Machinery Co. directors have declared the regular quarterly dividend of 2½ per cent, payable Jan. 10. The directors of the Union Switch & Signal Co. have declared quarterly dividends of 3 per cent on the common and preferred stocks, both payable Jan. 10, to stock of record Jan. 1. This increases the rate on the common from 8 per cent, and on the preferred from 10 to 12 per cent a year. Directors of Columbus Railway & Light Co. declared a dividend of 1 per cent on the capital stock of the company, payable January 15, 1907. The directors of the United Gas Improvement Co. have declared the regular quarterly dividend of 2 per cent, payable Jan. 15. Directors of St. Joseph Railway, Light, Heat & Power Co. have declared the regular quarterly dividend of 1¼ per cent on the preferred stock, payable January 1 to stockholders of record December 15. The directors of the Western Union Telegraph Company have declared a quarterly dividend of 1¼ per cent, payable Jan. 15. Directors of the Cumberland Telephone & Telegraph Company have declared the regular quarterly dividend of 1¾ per cent, payable Jan. 1. Directors of the Bell Telephone Co. of Missouri have declared a regular quarterly dividend of 2 per cent, payable Jan. 2, 1907. The directors of the Rochester Railway Co. have declared the regular quarterly dividend of 1¼ per cent on the preferred stock, payable Jan. 2. Directors of the Duluth Edison Electric Company have declared the regular quarterly dividend of 1½ per cent on the preferred stock of the company, payable Jan. 1. The Massachusetts Lighting Companies have declared the regular quarterly dividend of 1¼ per cent, payable Jan. 18. Directors of the Garvin Machine Company have declared the regular semi-annual dividend of 3½ per cent on the preferred stock, payable January 2. Directors of the West Philadelphia Passenger Railway have declared the regular semi-annual dividend of $5 per share, payable Jan. 2. The Havana, Cuba, Electric Railway Company has declared a quarterly dividend of 1 per cent on the preferred stock, payable Jan. 15. Directors of the Otis Elevator Company have declared the regular quarterly dividend of 1½ per cent on the preferred stock, payable Jan. 15. The Bell Telephone Co., of Canada, has declared a regular quarterly dividend of 2 per cent, payable Jan. 15. Directors of the United Traction Company, Pittsburg, have declared a regular semi-annual dividend of 2½ per cent, payable Jan. 19.

ELECTRIC COMPANY OF AMERICA.—In Philadelphia last week, at the stockholders' meeting of the Electric Company of America, President Snowden announced that the surplus on hand at the close of the last fiscal year had been expended and that more money had been borrowed for the company's use. The stockholders of the company ratified the agreement made by the directors to sell the property to the Electric Bond & Share Co. under conditions heretofore printed. The vote was over 80 per cent in favor of ratification. Contrary to the general impression, the proposed transaction between the Electric Company of America and the Electric Bond and Share Company does not contemplate an exchange of the individual Electric Company of America stock. The transaction involves a direct sale of the Electric Company of America properties, the agreement providing for the transfer of the entire assets in consideration of the delivery to the Electric Company of America of $6,282,000 5 per cent collateral trust bonds of the new corporation. The E. C. A. Company will receive at stated periods the interest on these bonds and disburse to its stockholders the regular 7 per cent annual dividend. Provision has been made whereby stockholders will receive the accrued dividend from July last. The E. C. A. will retain its corporate existence and the stock will still remain on the market. Provision has been made in the agreement for the indefinite existence of the E. C. A. Company, the Electric Bond & Share Company contracting to pay the annual corporate expenses. After the proposed contract with the Electric Bond and Share Company is concluded, it is the intention of the E. C. A. management to make a formal proposal to stockholders to exchange the new bonds for the outstanding stock on the basis of $14 in bonds for each share of stock. There is no obligation on the part of the stockholders to do this, however, and any stockholder may still retain his stock, receiving thereon the regular 7 per cent. dividend.

BONDS OF NATIONAL LAMP.—Lawrence Barnum & Company, Philadelphia, New York and Boston, have offered at 95 and interest $100,000 first collateral trust 5 per cent gold bonds, series "A," dated November 1, 1902, and due November 1, 1932. Interest payable May 1 and November 1 at the United States Mortgage & Trust Company, New York, trustee. A sinking fund is provided for the redemption of 3 1/3 per cent of "A" bonds outstanding each year, either by purchase in the open market, or, if they cannot be bought below par, the bonds are to be drawn for redemption at par and interest. After November 1, 1911, the sinking fund must pay 106 and interest if the bonds are drawn for redemption. The company reserves the right to retire any or all of the bonds by purchase at 106 and interest. The following is data of interest: Funded debt: First collateral trust 5 per cent sinking fund gold bonds (two series of $2,000,000 each), authorized, $4,000,000; outstanding, $2,457,175. Capital stock (in shares of $100 each), preferred, $150,000; common, $500,000. The company has paid dividends of 5 per cent on the preferred stock since formation, and last year a first dividend of 10 per cent was paid on the common stock. The company was organized in 1901 (under the laws of New Jersey) and acquired a number of the most important concerns manufacturing incandescent lamps in the United States, and now owns the entire stock of 20 different companies and the controlling interest in four others. None of the underlying companies, the stock of which is deposited as security for these bonds, has any mortgage indebtedness, excepting bonds of the New York & Ohio Company, $56,000; and the National Electric Lamp Company has no mortgage debt, excepting $75,000 on its factory property in Cleveland. The indenture securing these bonds forbids the creation of any mortgage or other indebtedness, except current accounts, that will be a prior lien to these collateral trust bonds. The company entered into an agreement whereby it secured a license under patents of the General Electric Company relating to incandescent lamps, and since has operated under a commercial policy in close harmony with the latter concern.

Earnings for Past Three Years.

	1905.	1904.	1903.
Gross profits	$618,727	$379,085	$553,642
Depreciation on plants and adjustments	168,461	83,537	97,688
Depreciation, good-will	30,000	30,000	30,000
Net earnings	$420,266	$265,548	$425,954
Bond interest	127,162	123,278	102,156
Dividends on pfd. (5%)	7,500	7,500	7,500
Dividends on common (10%)	50,000	—	—
Balance, surplus	$235,604	$134,770	$316,298

For the first four months of 1906 the company reports gross earnings of $284,728 and net earnings of $222,134, after charging off $62,593 for depreciation. The interest charges for the full year call for $127,161.

WESTERN UNION EARNINGS.—There appears to be little expansion in the telegraph business, as compared with the rapid growth in other branches of electric industry. The Western Union Telegraph Company's quarterly report for the quarter ending Dec. 31, 1906, shows a decrease of $407,593 in net revenues, as compared with the same period last year. There has been a gradual falling off in net revenue since 1903, the quarterly report for the period ending Dec. 31, 1903, representing $747,196 excess in net revenue over the present report. The annual report for the year ending June 30, 1906, showed that the net revenue decreased $117,481, as compared with 1905, and that the surplus over all charges and dividends decreased $218,261, while the operating expenses were $1,759,502 in excess of the preceding year. However, there was an increase in gross revenue for 1906 amounting to $1,642,019. Large sums of money have recently been spent in purchase of new supplies and in reconstruction of lines. The cost of improvements for the year ending June 30, 1905, was the largest in the company's history. In the same year the losses resulting from the discontinuance of race reports made a decrease in the total earnings of $215,755. A proportionate decrease could not be made in the expenses, which have steadily grown on account of the increasing messenger business. The report for the fiscal year ending June 30, 1906, shows improvements which might properly have been charged to capital account, but have been put under operating expenses. The net growth of the plant for the years was: In poles and cables, 2,735 miles; in wire, 71,560 miles; in offices, 509.

PACIFIC STATES TELEPHONE BONDS.—The new company to be known as the Pacific Telephone & Telegraph Company, will take over by purchase the property of the Pacific States Company in California, lease its property outside of California, and lease the property of the old Sunset Telephone Company, which has about $2,500,000 bonds outstanding to be retired at maturity. The American Telephone Company has ambitious plans for the development of the coast. During the first four or five months of 1906 the new installations by the Pacific States Company averaged 3,300 monthly. It is planned to increase this to 8,000 to 10,000. The Pacific coast already has the greatest telephone density of any part of the United States. There are 20,000 farms now served by telephone there, though in California alone there are 150,000 farms. Of the 51,000 stations destroyed by the San Francisco fire, 21,000 have been replaced. The present authorized capital of the Pacific States Company is $20,000,000, of which $17,000,000 has been issued, limiting the possible bond issue to $20,000,000, which the directors felt too small for development the next eight or ten years. The formation of the new company with an authorized stock issue of $50,000,000, of which about $35,000,000 will be issued at once, will permit the authorization of a similar amount of bonds, to be issued in lots of $3,000,000 to $4,000,000 yearly. All of this will be required by the rapid growth of the business.

PROFITS OF METAL MINING.—The high prices of copper obtaining during the past year have added greatly to the profits of the mining and metal industries, of which 115 leading companies, according to the figures compiled by *The Mining World*, have paid in dividends in the last eleven months a total of $84,648,163. These same companies, this authority figures, have disbursed since their incorporation the enormous total of $521,224,928, or about two-thirds of their aggregate capitalization of $780,014,145, and thirty-five of them, representing capitalizations of from $20,000 to $30,000,000, have returned their share capital, at least in full, some of them with a large addition. "Twenty-eight copper companies," says *The Mining World*, "declared dividends for the eleven months this year aggregating $56,093,273, making their distribution since organization $334,970,446 on the issued capitalization of $349,143,310, a return of about 96 per cent. Nine zinc properties announced dividends of $1,407,994 for the same period, making $10,225,169 since incorporation on an issued capitalization of $10,016,325."

TUNNEL MORTGAGE.—The New York State Railroad Commission has granted permission to the Hudson & Manhattan Railroad Company, which is constructing the so-called McAdoo tunnels under the North River, to issue a mortgage of $100,000,000. It was explained by Charles A. Collin, who appeared for the company, that it desired to refund the mortgages of the companies, which had been combined into the Hudson & Manhattan Company, and that the assent of 90 per cent of the stockholders had been received. It is proposed that the mortgage should be issued to cover 4½ per cent. bonds to the same amount. Of these, $43,000,000 will be held in reserve to meet the needs of the future development of the company, and the other $57,000,000 are to be used to cancel the outstanding obligations of the constituent companies, which bear interest at the rate of 5 and 6 per cent.

GENERAL ELECTRIC STOCK.—President Coffin, of the General Electric Company, has prepared a circular for stockholders, giving the terms on which the $10,861,200 of new stock authorized is to be offered to stockholders. Stockholders of record December 8, 1906, will be entitled to subscribe in the ratio of one new share to each five shares held, the right to subscribe expiring Jan. 16, 1907. Upon payment of the first 50 per cent subscription price Jan. 16, 1907, warrants must be presented to the transfer agent for endorsement. Interest at 8 per cent will be allowed on the first payment until April 16, 1907, the date of the second and final payment. Both payments may be made January 16. It is reported from Pittsfield that the General Electric Company has practically decided upon additions to the Stanley plant which will call for the expenditure of $2,000,000.

AMERICAN UNION TELEPHONE.—The American Union Telephone Company, a consolidation of nearly all the independent telephone companies in Pennsylvania and West Virginia, was permanently organized last week at a meeting of its board of directors in Harrisburg. Ellis Orvis, of Bellefonte, Pa., was elected president; B. F. Meyers, of Harrisburg, Pa., vice-president; S. R. Caldwell, secretary and treasurer; Lyman D. Gilbert, of Harrisburg, general solicitor; Colonel C. M. Clement, of Sunbury, Pa., assistant solicitor, and George W. Reily, member of the executive committee for Harrisburg. F. D. Houck, of Harrisburg, was elected general manager.

WESTERN ELECTRIC STOCK.—It is stated, from Chicago, that the Western Electric Company is likely to issue from $3,000,000 to $5,000,000 of new stock early in 1907, to take care of its rapidly growing business, which is taxing all its resources of men, money and machinery.

GENERAL NEWS.

Construction News.

GADSDEN, ALA.—The Coosa River Power & Electric Light Company has succeeded in getting the consent of the Government for the construction of a 30-foot dam at Lock 3, the proposed site of the plant, which will develop 15,000 hp. William L. Church is consulting engineer.

SACRAMENTO, CAL.—The Board of Trusteees has granted the Northern Electric Company a 50-year franchise to operate an electric railway in the city.

SAN BERNARDINO, CAL.—The Council Board has decided to erect a plant to furnish heat, light and power for public buildings. The probable cost is placed at $40,000.

RIVERSIDE, CAL.—The Crescent City Railway Company has applied for a franchise to cross the county roads between the Sky Blue Marble Quarries and Highgrove. The line will be between three and four miles long.

SELMA, CAL.—Negotiations are now under way for the sale of the plant and holdings of the Selma Light & Water Company to the San Joaquin Light & Power Company. A. G. Wishon is manager of the San Joaquin Light & Power Company.

REDDING, CAL.—The Northern California Power Company has purchased the Manzanita water rights and land owned by A. W. Smith, for a consideration of $15,000. The company is preparing to utilize the extra water by turning it into Bear Creek.

SAN DIEGO, CAL.—A petition has been granted by the City Council to the San Diego Electric Railroad Company for franchises to operate and construct three new lines in the city. Work on the construction of the South Park and East Side trolley line has commenced.

REDDING, CAL.—The La Grange Hydraulic Mining Company is planning to build an electric railway over the mountains from the tidewater to Redding and its mining property. The company has secured a tract of land, on which a power station will be erected.

PASO ROBLES, CAL.—The question of erecting a municipal water and light plant is now being considered in this place. At a meeting of the citizens held recently it was decided to request the City Trustees to secure the services of an engineer to make an estimate of the cost of a plant.

SAN FRANCISCO, CAL.—The Northern California Power Company has let the contracts for the new centrifugal pumps and the new electric motors for the new water system which is to be installed just as soon as the machinery can be placed on the ground. G. W. Price & Company, of San Francisco, will supply the pumps, which will have a capacity of 1,800,000 gallons each a day. Each pump will be direct connected to a 150-hp motor.

SAN BERNARDINO, CAL.—The San Bernardino Valley Traction Company has disposed of all its rights, title and interest to the San Bernardino Interurban Railroad Company, which was recently organized for the purpose of taking charge of the Riverside extension and other possible connections which are under consideration. At a meeting of the board of directors of the new interurban company held Dec. 1, $250,000 was provided for the Riverside extension, and the following officials elected: Victor Smith, president; H. E. Harris, vice-president; A. G. Kendall, secretary and treasurer.

COLORADO SPRINGS, COL.—W. C. Dotterer and Wesley Compton, representatives of an eastern syndicate, have made application to the Town Board of Manitou for an electric railway franchise through the city. The syndicate is planning to build an electric line from Manitou into the Crystal Park country at a cost of $250,000.

CANON CITY, COL.—Frank D. Heath, the electric railroad promoter, reports that he has arranged for the financing of the Canon City & Royal Gorge Electric Railway line, and that $500,000 will be invested just as soon as the city will raise a bonus of $30,000 for the enterprise. The plans cover eighteen miles of track, extending from the Denver & Rio Grande depot to the top of the Royal Gorge. With Mr. Heath are associated Willis Wood and William Huddick, of Kansas City, and W. W. Unbenhur, of Philadelphia, Pa.

BRIDGEPORT, CONN.—The United Illuminating Company has petitioned the Common Council for permission to place its wires underground.

NORWICH, CONN.—The Lebanon Street Railway Company has completed the preliminary survey for its line from Chestnut Hill to South Manchester.

CANAAN, CONN.—The Berkshire Power Company has completed arrangements, and has signed a contract for lighting the streets of Millerton with electricity.

NORWICH, CONN.—The Consolidated Railway Company has submitted a petition to the municipal authorities for a local franchise to double track its line from Norwich to Taftsville.

WATERBURY, CONN.—The Woodbury & Waterbury Street Railway Company has awarded the contract for the construction of an electric railway from the Waterbury town boundary through Middlebury to Woodbury.

TORRINGTON, CONN.—The Torrington Manufacturing Company is now operating its factory by electricity, the energy being supplied by the Torrington Electric Light Company. The lighting company also furnishes electricity to operate the Coe Brass Works.

MANCHESTER, CONN.—The Glastonbury Company, which is to supply electricity for the Manchester Light & Power Company, will erect a new station on Hilliard Street, west of the South Manchester Railroad tracks, and a sub-station will be erected at the north end of the town.

STONINGTON, CONN.—The Westerly Electric Light & Power Company, of Westerly, R. I., which owns the Mystic Electric Light plant, it is stated, has petitioned the Selectmen of Stonington for permission to cross the highways of the town in establishing its new line of power wires. The company intends to furnish heat and power as well as light along its lines as far as Noank. J. M. Klingelsmith is president.

EAST NORWALK, CONN.—The citizens voted Dec. 8 to ask the Legislature to grant them power to build a municipal electric light plant to provide electricity for street lighting and other purposes, and to sell electricity for private use, or the right to buy electric energy from the city of South Norwalk, or any other corporation. A committee has been appointed to appear before the next session of the Legislature and apply for permission for the above.

WILMINGTON, DEL.—Anthony Higgins, representing the Commercial Light, Heat & Power Company, has announced to the Street and Sewer Department that the electric portion of the franchise recently granted to the company is to be transferred to the Delaware Electric Transmission Company, power to be taken from the Susquehanna River, and the Commercial Company to be allied with the transmission company.

WASHINGTON, D. C.—Bids will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until January 2, 1907, to furnish at the navy yards, etc., at Portsmouth, N. H.; Boston, Mass.; Newport, R. I.; New York, N. Y.; League Island, Pa.; Annapolis, Md.; Washington, D. C., and Norfolk, Va., a quantity of naval supplies as follows: Schedule 314—armatures, electrical supplies, etc. Schedule 315—copper wire, etc. Schedule 317—electrical supplies, engine indicators, revolution counters, etc. Application for proposals should designate the schedules desired by number. E. B. Rogers, Paymaster General, U. S. A.

SANDERSVILLE, GA.—C. J. Rogers, city clerk, writes that the citizens voted Dec. 5 to issue $10,000 bonds for water works and lighting improvements.

COLUMBUS, GA.—The Eagle and Phoenix Mills have placed a contract with the General Electric Company for generators, motors and other electrical equipment which will cost $16,000. The plant will have a capacity of 675 hp and will supply electricity to operate individual motors for different departments of the mill.

SPRINGFIELD, ILL.—The City Council has granted a franchise to the Springfield & Southwestern Interurban Company to construct a line into the heart of the city.

PEORIA HEIGHTS, ILL.—The village of Peoria Heights has offered $15,000 worth of water mains to any company or corporation which will erect a water power plant within the village limits, and furnish power and water to the residents.

STERLING, ILL.—The stockholders of the Rock River Traction Company has authorized the issuance of bonds to the amount of $2,000,000, the proceeds to be used for the purpose of constructing an electric railway from this city to Rock Island, from Rock Island to Geneseo; also to Princeton, and a branch from this city to Morrison. The total distance planned to be covered is 125 miles.

CHICAGO, ILL.—The Economy Light & Power Company has increased its capital stock from $850,000 to $3,500,000. The interests of the Economy Light & Power Company and those of the Logan-Munroe syndicate have been consolidated. Frank G. Logan and Chas. A. Munroe are among the directors. The company, it is stated, intends expending $2,000,000, and constructing a dam and power plant at the head of Lake Joliet, and also a power plant near the head of the Illinois River. The two plants will furnish about 15,000 hp.

CHICAGO, ILL.—Sealed proposals will be received by the city electrician until December 24 for furnishing the Department of Electricity with 36,000 feet of 3-conductor insulated, lead-incased electric light cable, to be used on 12,000-volt, alternating-current in underground service. Bids will also be received until December 24, for furnishing and placing in position electric motors in the municipal electric lighting stations of the city, located at Halsted and Sixty-fourth streets and Wentworth Avenue. William Carroll is city electrician.

MICHIGAN CITY, IND.—The Chicago, Lake Shore & South Bend Railway Company has purchased a site in the eastern portion of the city, on which it will erect a power house.

MUNCIE, IND.—The City Council has let a contract to a private corporation to light the streets of the city and has ordered an appraisement and sale of the municipal plant.

DILLSBORO, IND.—William J. Rowland, Wm. Flemming and J. H. Green are promoting an electric railway to connect this city with Versailles and Aurora. The road will be 30 miles in length.

COLUMBUS, IND.—The Columbus, Greenburg & Richmond Traction Company has been organized to build an electric railway from Columbus to Richmond. August M. Kuhn, of Indianapolis, is president.

KNIGHTSTOWN, IND.—The City Council has voted to install a new 300-hp gas engine in the electric light and water works plant. Other equipment will also be added, as the present plant is inadequate to the demands upon it.

CONNERSVILLE, IND.—A franchise has been granted by the City Council to the Connersville Street Railway Company for a street railway and bids will soon be called for the construction of a local system, which will include a power plant. R. Neil Burgess is vice-president.

GREENWOOD, IND.—As the result of low pressure during the recent fire which destroyed the Polk Canning factory, the City Council has decided to grant the Citizens' Light & Water Company a new franchise providing the company will at once rebuild and re-equip its plant.

MARION, IND.—The City Council is asking for bids on new equipment, so as to increase the capacity of the present municipal electric light plant, to permit the city to engage also in the commercial light and power business. Following this announcement the Marion Light & Heat Company has voluntarily reduced the price for commercial lighting.

LA PORTE, IND.—A franchise has been granted to the Goshen, South Bend & Chicago Railroad Company by the County Commissioners to build a line of track three miles in length, extending from a point in the center of the city to connect with the main line of the Chicago-New York electric road.

LAFAYETTE, IND.—Plans have been ordered for an addition to the power plant of the Wabash Valley Traction Company's plant in this city at a cost of $50,000. New machinery and equipment will be installed.

CENTERVILLE, IA.—The plant of the Centerville Light & Traction Company was destroyed by an explosion on Dec. 9. James Frady is chief engineer.

DES MOINES, IA.—The Mutual Telephone Company is contemplating the erection of a new exchange building on the East side, in which a central energy system will be installed.

WATERLOO, IA.—The plant of the Janesville Power Company has been sold and it is said that the purchasers will develop the power and furnish electricity for both Waterloo and Cedar Rapids.

KEOKUK, IA.—The County Board has granted a franchise to L. Behr & Company, of St. Louis, Mo., for an electric railway through the county. The proposed line is to run from Keokuk to Burlington.

OSCEOLA, IA.—The Tri-State Telephone Company has filed amendments to its articles of incorporation, changing its name to the Tri-State Telephone & Telegraph Company and increasing its capital stock to $120,000.

DES MOINES, IA.—The Interurban Railway Company has completed the preliminary survey for an electric railway from Des Moines to Carlisle, a distance of 12 miles. The company is contemplating the construction of a new line to the army post. F. S. Cummings is chief engineer.

ALMA, KAN.—Clarence Eck and Gus Mueller have sold their interests in the electric light plant to William Wilson, the senior member of the firm, who will conduct the plant in the future.

CLAY CENTER, KAN.—Bids will be received until Jan. 4 for three 66x18-in. tubular boilers, two steam engines, 120 and 200 hp, and two alternating-current generators with exciters and switchboard. Thomas G. Ryan is city clerk.

HUTCHINSON, KAN.—B. L. Spindler, of Hutchinson, general manager Interurban Railroad Company and the People's Water, Light & Power Company, writes that it is proposed to extend the railway, and increase the boiler capacity at the lighting plant in the spring.

LOUISVILLE, KY.—The Louisville Electric Light Company is ready to put its wires underground as soon as the Board of Public Works decides upon a plan. Udolpho Snead is president.

ELLSWORTH, ME.—Plans have been prepared for erecting a plant of 2,500 hp for the Bar Harbor-Union River Power Company. George W. West, of Portland, Me., is president.

AUBURN, ME.—The electric light plant of the Lewiston & Auburn Electric Light & Power Company, located on the Little Androscoggin River, was burned December 12, entailing a loss of $25,000.

DIXFIELD, ME.—The Dixfield Power & Light Company will soon be able to furnish electricity for lighting the streets and houses in the town. The company will secure power from the spool factory to operate its plant. Neewton S. Stowell is president.

AUGUSTA, ME.—John R. Graham, of Bangor, has purchased the Augusta, Winthrop & Gardiner Street Railway and the transfer will soon take place. Mr. Graham states that during the coming year he will build 50 miles of electric railway to connect the Augusta system with the Lewiston, Brunswick & Bath Street Railway.

CAMBRIDGE, MD.—Congressman Wm. H. Jackson, of Salisbury, Md., has decided to donate to the Cambridge Hospital an electric light plant. Henry Lloyd is president.

LOWELL, MASS.—The Gas Commissioners have authorized the Lowell Electric Light Corporation to issue 2,800 additional shares of capital stock at $170. The proceeds to be used for additions and improvements.

HAYDENVILLE, MASS.—The Mill River Electric Light Company has petitioned the town of Williamsburg for permission to extend its lines on several streets in that town, for the purpose of furnishing electricity for lighting purposes.

NORTHPORT, MICH.—Bonds to the amount of $10,000 have been voted for water works and an electric light plant.

MIDLAND, MICH.—A. W. Lewistein and Burton H. Carter, local capitalists, have been granted a franchise to build an electric railway in Midland.

KALAMAZOO, MICH.—The Council is considering an ordinance requiring all electric wires to be placed underground in the business district of the city.

MARQUETTE, MICH.—It is proposed to remodel the municipal electric light plant by constructing a new station installing a larger generator and extending the flume, at a cost of $97,000. Charles Retallic is superintendent.

DETROIT, MICH.—It is said that the Grand Trunk Railway is contemplating the construction of a double track electric railway between Port Huron and Detroit next year. This is said to be the outcome of the electrification of the tunnel.

COOPERSVILLE, MICH.—The Village Council, it is stated, has closed a contract with the Grand Rapids Muskegon Water Power Company to light the streets of the village. The contract calls for about forty 100-cp lamps. The company will also furnish commercial lighting and power to manufacturing plants.

MT. CLEMENS, MICH.—The St. Clair Edison Electric Company has asked for a franchise from the City Council, offering to furnish electricity at 12 cts. per kw-hour against a present price of 20 cts. The new concern has already placed its poles between its central plant in Detroit and this city and is now stretching its heavy feed wires.

DETROIT, MICH.—The City Council has passed the ordinance requiring all wires placed underground within the mile circle, the work to be completed by Sept. 1, 1907. The question of putting the wires underground within the mile circle has revived talk of a municipal conduit, owned and controlled by the city, in which space would be leased to the several corporations having wires strung about the streets.

CHISHOLM, MINN.—The Mesaba Telephone Company will erect a new telephone exchange building.

DULUTH, MINN.—The Zenith Telephone Company will make extensive improvements to the West Duluth system.

TRENTON, MO.—Frank D. Moses, of Trenton, N. J., has purchased the gas and electric plants in this city. A new company has been formed under the name of the Citizens' Gas & Electric Company, of Trenton, with a capital stock of $125,000, to take over the plants and many extensions will be made. S. F. Fulkerson, of Trenton, Mo., will be president of the new company; F. D. Moses, vice-president, and W. W. Levering, secretary and treasurer.

ST. LOUIS, MO.—The Interstate Light & Power Company has applied to the City Council for a 50-year franchise, to furnish the city with electricity for light and power. The company agrees to furnish with electric energy for lighting the streets and public buildings of the city at a rate not to exceed 2 cents per kw-hour. It also agrees to serve consumers at a rate not to exceed 3 cents per kw-hour. The city now pays 4¼ cents per kw-hour for electricity in streets and public buildings south of Washington Avenue and 5 cents per kw-hour north of that avenue.

EXCELSIOR SPRINGS, MO.—The Excelsior Springs Light, Power, Heat & Water Company will double the capacity of its plant. A new unit of 150 kilowatt capacity will be installed, for which the contract has been awarded.

JOLIET, MONT.—E. Corle proposes constructing an electric light plant.

BUTTE, MONT.—The City Council has granted the Daly Davis Estate Mining Company permission to construct and operate car lines from its properties to the gulches west of the city.

VALPARAISO, NEB.—D. M. Deas is contemplating the construction of an electric light plant.

PLATTSMOUTH, NEB.—Jos. A. Borterlanger, of Glenwood, Ia., has applied for an electric light franchise in this place.

LINDSAY, NEB.—Paul Van Ackeren has decided to install an electric plant at this place. He has contracts for 400 lamps and expects to put in about 800 when the plant is installed.

OMAHA, NEB.—Plans, specifications and estimates on contracts for the complete electrical construction and equipment of the new interurban electric railway, to run between Omaha and Hastings, are being prepared by the Westinghouse Electrical & Manufacturing Company for the Omaha & Nebraska Central Railway Company, which is promoting the enterprise.

OMAHA, NEB.—It is announced that the Omaha Independent Telephone Company will erect a central exchange near the business center of the city at a cost of $200,000, and three sub-exchanges ranging in cost from $30,000 to $50,000. A contract has been closed between the Heim-Parmele-Pollock Company and the Union Construction Company for the construction of the telephone system. Active work on the construction of the system has been postponed until spring.

EAST WASHINGTON, PA.—The Pittsburg Railways Company has been granted a 99-year franchise to construct and operate a street railway in this place.

ALTOONA, PA.—The Citizens' Electric Illuminating Company is pre-

paring to install the 22 additional arc lamps which were recently authorized by the City Council.

WEST CHESTER, PA.—The Philadelphia & West Chester Traction Company is contemplating the construction of a branch line from Clifton through the borough of Aldan.

PHILADELPHIA, PA.—Bids will be received until Dec. 21 by the commissioners of Fairmount Park for lighting by electricity and naphtha for the year of 1907. Jesse T. Hodges is superintendent.

NANTICOKE, PA.—Bids will be received by the American Pipe Manufacturing Company, Philadelphia, until Jan. 15 for the construction of a power house, head and tail race, etc., at Nanticoke.

CARBONDALE, PA.—Supervisor Thos. Horner and D. M. Lynch are said to be interested in the forming of a company for the purpose of furnishing electricity for lighting in the township of Fell.

NEW CASTLE, PA.—The New Castle & Harmony Electric Railway Company has purchased a site on Pittsburg, Cunningham and Kurtz streets, which will be used as a station and terminal for the new electric railway system.

ALTOONA, PA.—C. S. Downs, city electrician, writes that the contract for lighting the city for a period of 3 years has been awarded to the Edison Electric Illuminating Company, of Altoona, at $50 per lamp per year for 400 lamps.

ALTOONA, PA.—An offer to furnish Altoona with electric energy at 1½ cents per kw-hour for street lighting purposes has been made by the Juniata Hydro-Electric Company, whose plant, operated by water, is located near Huntingdon. The city must erect its lines and poles and maintain them.

SCRANTON, PA.—Many improvements are contemplated by the Scranton Railway Company during the next year. Plans are being prepared for a new power house which will cost about $300,000. Orders have been placed for new cars with double tracking and the extension of several lines; the company will expend about $600,000 on its system.

OXFORD, PA.—The Borough Council has made a contract with the Oxford Electric Light & Power Company for lighting the streets for a term of three years. By the terms of the contract the town is to have eight arc lamps and 104 incandescent lamps for the sum of $2,368 per year, the incandescent lamps to cost $17 each per year. D. M. Taylor is president of the lighting company.

HUNTINGTON, PA.—An application for a charter will soon be made under the name of the Big Valley Electric Street Railway Company by R. W. Jacobs, F. Blair Isenberg, H. E. Steel, Wallace W. Wilson and George C. Wilson, the promoters of the Juniata Valley Electric Street Railway Company's line now being built in Huntington, and who are seeking additional charter rights through the borough and to Mt. Union, under the corporate name of the Juniata Street Railway Company. Application has also been made for a charter by the Alfarta Electric Railway Company through S. J. Spyker, attorney. The incorporators are John Phillips, W. G. Kenagoa, H. H. Knode, G. N. and S. S. Spyker. This road will be single track, 12 miles long.

HIGHTSTOWN, N. J.—The trustees of Peddie Institute are considering the erection of a central heating, light and water plant, at a cost of $20,000.

BAYONNE, N. J.—The Public Service Corporation has secured the contract to furnish the city with gas and electric street lights. The corporation agrees to furnish arc lamps of 2,000 cp at $85 per lamp per year provided there are not less than 250 lamps, or $80 per lamp per year for 350 lamps, and gas lamps of 15 cp each at $15 per lamp a year.

ROCHESTER, N. Y.—The Rochester Railway Company is contemplating extending its West Avenue line to Lincoln Park next summer.

BROOKLYN, N. Y.—The Brooklyn Rapid Transit Company has recently placed an order with the Westinghouse Machine Company for five turbo-generators having a capacity of 10,000 kw each, at a cost of $2,500,000.

LESTERSHIRE, N. Y.—At a meeting of the water board it was decided to install a new power plant and to call a special election next March to vote on the question. The board also decided to install three new boilers.

ALBANY, N. Y.—Howard Hendrickson, president of the Albany Home Telephone Company, purchased at auction the Colonial Telephone Company, of Newburg, for $15,000. The sale resulted from an action brought against the Colonial Company by the Union Trust Company, of New York.

BUFFALO, N. Y.—The State Board of Railroad Commissioners has granted the Hamburg Railway Company permission to issue a mortgage for $750,000. The company has $650,000 of stock to be issued, $300,000 of which is to be used for betterments. The mortgage will eventually be taken up by the holding company of the Sheehan-Mayer traction interests.

GLENS FALLS, N. Y.—The Glens Falls Gas & Electric Light Company has purchased the property and holdings of the United Gas & Electric Company, operating in Sandy Hill, South Glens Falls and Ft. Edward. It is stated that the company will erect an electric power plant in Sandy Hill to supply Washington, Warren and Saratoga counties with electricity and extend its lines to the several villages in these counties.

BUFFALO, N. Y.—The Buffalo & Lackawanna Traction Company has purchased the franchise for the electric street car line from the steel plant along the Hamburg turnpike and through various streets to the Lafayette Square. The company will spend a large amount of money for the improvement of the Hamburg turnpike, and when completed a through double-track line will be in operation from Main Street in Buffalo to the city of Erie, Pa.

UTICA, N. Y.—The Hudson River Power Company expects to be able to furnish about 10,000 hp at the local station by the middle of January. Only one more machine remains to be placed to complete the equipment of the plant. The company has nearly completed its transmission line from the local plant to the West Shore Railroad at Clark Mills, where power will be provided for the operation of the electric cars. Eugene L. Ashley is president.

SYRACUSE, N. Y.—At a meeting of the stockholders of the Syracuse Lighting Company Dec. 6 it was voted to increase the capital stock from $3,000,000 to $8,000,000 and to lease the plant and business to the recently formed Onondaga Lighting Company. While the vote was practically unanimous, the new stock cannot be issued nor the lease executed until an injunction granted by Supreme Court Justice W. M. Rogers is disposed of. This injunction was secured by former Mayor J. B. Kline, of Syracuse, acting as attorney for James M. Bissell, of Hartford, Conn. The proposed action of the stockholders must meet the approval of that commission before it becomes legal.

BUFFALO, N. Y.—The city has entered into an agreement with the Cataract Power & Conduit Company to supply the city with electricity to operate the electric motor and pump at the water works for a period of two years at a flat rate of $3,125 per month, and to supply the same amount for the second pump when installed. This is equivalent to the rate of $25 per horsepower per year for a 1,500-horsepower motor. The General Electric Company agreed to furnish the city departments as follows: For fire and police departments, 4 cents per kw-hour; Convention Hall, a flat rate of 6 cents; the present maximum of 9 cents to apply only to school and other buildings where the installations are small.

NEW YORK, N. Y.—Bids will be received by the Commissioner of Water, Gas and Electricity at Room 1536, 13 to 21 Park Row, New York, N. Y., until Dec. 31, for furnishing, operating and maintaining electric lamps for lighting streets, avenues, public buildings, parks and public places, from Jan. 1, 1907, to Dec. 31, 1907, both inclusive: For lighting streets, avenues, public buildings, parks and public places in the City of New York; No. 1, Borough of Manhattan; No. 2, Borough of The Bronx; No. 3, Borough of Manhattan and The Bronx; No. 4, Borough of Brooklyn; No. 5, Borough of Queens; No. 6, Borough of Richmond. The amount of the security required is twenty-five (25) per cent of the amount of the bid or estimate. Blank forms may be obtained at the office of the department. John H. O'Brien is commissioner.

SARANAC LAKE, N. Y.—The State Railroad Commissioners have consented to the issuance by the Paul Smith Electric Light & Power & Railroad Company of a first mortgage for $500,000 on condition that but $400,000 bonds shall be issued under the mortgage under this consent and that before the remaining $100,000 bonds or any part thereof shall be issued the company shall apply for and receive the consent of this board to its issuance. The commissioners have also approved of an increase of the capital stock of the company from $100,000 to $500,000, on condition that but $100,000 of said increase of stock be issued under this approval and that the remaining $400,000 of said increase of stock or any part thereof shall not be issued until after further application is made to the board by said company for approval of the issuance.

ELYRIA, OHIO.—The Dean Electric Company has awarded the contract for enlarging its power plant to the Osborne Engineering Company, of Cleveland.

KENTON, OHIO.—R. G. and E. M. Gerlin, of Toledo, will purchase the plant of the Kenton Gas & Electric Company for $100,000. They take possession April 1, 1907.

HAMILTON, OHIO.—John W. Hill, engineer of the Cincinnati water works, has been retained by the Board of Public Service to superintend the rehabilitation of the Hamilton water works and electric plant.

ELYRIA, OHIO.—The Dean Electric Company has been reorganized with a capital of $1,000,000. The company contemplates doubling the capacity of its plant and erecting new buildings. W. W. Dean is vice-president.

CLEVELAND, OHIO.—Bids will be received until Jan. 3 by Peter Witt, city clerk, for a franchise to construct a street railway to be operated by electricity on portions of East 66th Street, Storer and Trowbridge Avenues.

MARYSVILLE, OHIO.—The Magnetic Springs & Northern Electric Railway Company, which is constructing a line from Magnetic Springs to Richwood, has filed a mortgage securing a loan of $400,000 made by the Colonial Trust Company, of Pittsburg, Pa. The money will be used to pay off the present indebtedness of the company, to complete the line and later to build an extension from Richmond to Larue and eventually to Marion.

CLEVELAND, OHIO.—Bids will be received until Dec. 28 by the Board of Public Service for furnishing, lighting, extinguishing and keeping in repair, including the furnishing of electricity and all materials necessary therefor, about 1,300 electric arc lamps for a period of one year from Jan. 1, 1907. A separate bid will be made for each of two districts, one comprising all the territory in the city west of the Cuyahoga River, requiring about 350 lamps, and the second all the territory east of the Cuyahoga River, requiring about 950 lamps. A. R. Callow is secretary.

COLUMBUS, OHIO.—It has been definitely decided that no state house electric lighting plant will be installed under the provisions of the law passed by the Legislature, appropriating $25,000 for the purpose. The reason given is that the Columbus Public Service Company

has made a bid one-fourth lower than its present rate, which is considered cheaper than the State could operate its own plant. As an alternative the law provides that if the plant is not erected the state house and judiciary building shall be rewired and Nernst lamps installed with the money. The Columbus Public Service Company is now getting 3 cents per kw-hour for electricity and now offers to furnish it for 2¼ cents. The estimated cost of operating a State plant is from 2 cents to 2½ cents per kw-hour. The Public Service Company will get a two-year contract, with the right reserved to the State of cancelling on 30 days' notice.

OKLAHOMA CITY, OKLA.—Financial arrangements have been made for the construction of the interurban lines of the Oklahoma City Street Railway Company from Oklahoma City to Chickashaw and the Reno, Guthrie, Purcell and Shawnee. The lines will cost $800,000, and the preliminary surveys will be made after Jan. 1. The Guthrie-Purcell line will be built first.

BAKER CITY, ORE.—J. K. Romig, president of the Eagle River Power Company, has closed a contract with the General Electric Company for a complete equipment of machinery to develop 2,500 hp at the new Eagle River power plant at Sanger, one of the mining camps northeast of Baker. The entire output of this new plant has been contracted for in advance. Part of it will be used by the old Virtue mine.

PORTLAND, ORE.—The consolidation of more than a dozen electric light, traction and power plants in cities of the Pacific Northwest by Philadelphia capital has been announced. The properties merged under one management have a valuation of $6,000,000. Rhodes, Sinkler & Butcher, of Philadelphia, Pa., and other Philadelphia capitalists are behind the project. A. L. Welch, of Portland, is to be manager of the consolidated properties. The scheme of consolidation contemplates an extensive development of the Willamette Valley. Electric railways are projected to cover much of the valley now without modern transportation facilities. Electric energy generated either by mountain streams or by steam plants, will furnish electricity to many communities. The properties so far secured or now held under option by the Eastern bankers are the light and power plants at Eugene, Springfield, Albany, Cottage Grove, Corvallis, Seaside, Roseburg, Baker City, Walla Walla, Wash., and Pendleton, Ore. Electric plants at Dallas and Albany are owned by the promoters of the consolidation, as are also gas plants at North Yakima, Wash., and Lewiston, Idaho.

ALLENTOWN, PA.—General Superintendent West of the Consolidated Telephone Companies has concluded negotiations whereby the Consolidated leases for 999 years the Slate Belt Telephone Company of Northampton County. The Slate Belt Company has about 500 miles of lines and five exchanges, located at Nazareth, Bath, Bangor, Pen Argyl and Portland. In the spring a line 16 miles long will be built from Portland to Stroudsburg, taking in the Delaware Water Gap.

AVALON, PA.—The Ohio Valley Light Company has entered into an agreement with the Avalon Borough Council to furnish 25 or more arc lamps at $70 each per year, and 50 or more metalized filament lamps at $25 a year per lamp for five years from March 1, 1907. This is a reduction of $10 a year per arc lamp from the present contract, which would not have expired until March 1, 1909. The Central District & Printing Telegraph Company was granted the right to place its wires underground.

PAWTUCKET, R. I.—The J. & P. Coats Thread Company has awarded a contract for the erection of a new power house at the corner of Pine and Rand Streets. The plant when completed will furnish electricity for light, heat and power for the entire works of the company.

WOONSOCKET, R. I.—The Woonsocket Electric Machine & Power Company is now installing two Curtis steam turbines in its station on Front Street. The machines will be used principally to furnish power for the Providence & Burrillville Street Railway line. It is expected to have them in operation by June 1.

BISHOPVILLE, S. C.—The Town Council has purchased the entire plant and holdings of the Bishopville Light & Power Company, at a cost of $20,000. The plant will hereafter be operated by the town.

COLUMBIA, S. C.—A petition has been made to the City Council by the Suburban Transit Company for a franchise for an extension of its street car line to Colonial Heights about a mile north of the city.

CHARLESTON, S. C.—C. L. de Muralt, New York, N. Y., has secured the contract for the power plant and machinery for the Navy Yard, Charleston, to include Atlas boilers, Murphy stokers, Wheeler condensers, Foster superheaters and Sturtevant economizers, for $83,500.

CLARKSVILLE, TENN.—The Council is said to be considering the ordinance requiring the placing of all wires in the fire district underground.

ALGOOD, TENN.—An electric light plant has been installed here. Many of the mills, residences and hotels in the town are being wired for electric light.

BRONTE, TEX.—A company has been organized and is now building an electric plant. Frank Hickman is president.

HOUSTON, TEX.—The Houston Lighting & Power Company has decided to put in an underground system at a cost of about $300,000. W. H. Chapman is manager.

COOPER, TEX.—James W. Hockaday, of the Cooper Electric Company, writes that the electric light plant recently burned is now being rebuilt. The company will need an engine.

McKINNEY, TEX.—A franchise has been granted by the City Council to the Texas Traction Company to construct and operate the Dallas-Sherman interurban line through the city. The main power station is to be located within two miles of this city. J. F. Strickland, of Dallas, is president of the company.

SALT LAKE CITY, UTAH.—A permit has been granted to the Salt Lake Public Service Company to erect a brick power house on Third West Street, which will cost about $45,000.

SALT LAKE CITY, UTAH.—The County Commissioners have granted a franchise to the Institute Electric Company to construct and maintain a light and power system along certain highways in the county.

SALT LAKE CITY, UTAH.—A. Z. Richards, of Salt Lake City, has made application to appropriate water from Little Cottonwood Creek for power purposes. The plants and transmission line will cost about $20,000.

SALT LAKE CITY, UTAH.—Lucien L. Nunn, of Provo, associated with the Telluride Power Company, has filed application for water rights on Rock Creek, a tributary of the Duchesne River. The plan contemplates the development of 150,000 hp.

SALT LAKE CITY, UTAH.—The Utah Light & Railway Company is extending its transmission lines to Huntington. It is estimated that the company will expend more than $200,000 in this county during the next year. The company will soon extend its line to North Ogden and the Utah Hot Springs.

SALT LAKE CITY, UTAH.—An electric railway from Montpelier, Ida., to Bear River City, Boulder County, is under consideration by the Harriman people. The line has been surveyed, and power to operate the road will be secured from a tributary of the Bear River. The stream is capable of developing 1,200 hp.

SALT LAKE CITY, UTAH.—Gaylie R. Cleveland, of Salt Lake City, has applied to the State Engineer for 7 cu. ft. of water per second to be diverted from the Jordan River, in Utah County. The water will be taken for the purpose of generating power for electrical purposes in American Fork canyon and Alta. The plans include a diverting channel of 6,000 feet and two Pelton wheels and other machinery sufficient to generate 400 hp.

WATERBURY, VT.—The Consolidated Lighting Company is installing a new turbine of 1,000 hp in its plant in Northfield. This unit will be used in case of emergency.

BENNINGTON, VT.—The Consolidated Railway Company has taken over the property and franchises of the proposed lines of the Bennington & Hoosac Valley electric road, which is building the new electric railway from the Massachusetts State line into Bennington. The present officers of the road have arranged to operate the road until the new line is completed.

RUTLAND, VT.—The Rutland City Electric Company will soon discard its steam plant and will operate its system from the hydro-electric plant at Chittenden. The steam plant will be kept intact to be used in case of emergency. A 500-kw frequency changer set will be installed in the Cleveland Avenue sub-station about Feb. 1, when the entire load will be carried by the water power plant.

LYNCHBURG, VA.—The Board of Aldermen, on December 11, defeated the project looking to the establishment of a municipal electric light plant. A special committee has recommended to the Board that the Council make provision for a 10-year contract with the local traction company on a basis of 300 lamps at 15 cents per lamp each night. The company has agreed to this contract with a proviso that after a term of years, the city may become owner of the lighting plant of the company. The report was adopted by the Board.

CENTRALIA, WASH.—The City Council has granted a franchise to the Oregon & Washington Railway Company.

SPOKANE, WASH.—The Spokane & Pend d'Oreille Rapid Transit Company has applied for a franchise on several streets of the city.

CHENEY, WASH.—Charles P. Lund has been granted a franchise by the City Council to equip and operate an electric railway system in this city.

SEATTLE, WASH.—The Council has passed the ordinance granting a franchise to the Seattle Electric Company over Westlake and Second Avenues, and other streets over the mayor's veto.

ELLENSBURG, WASH.—The County Commissioners have granted a franchise to the North Kittitas Rural Electric Company for the construction of electric lines for the transmission of electricity, light and power, for period of fifty years.

RIVERSIDE, WASH.—Plans are being made for lighting this town with electricity. Hugh Gibbons has installed a small electric light plant and contemplates increasing the capacity of the plant to furnish the town with 216 incandescent lamps of 16 cp.

SEATTLE, WASH.—The Seattle Electric Company is making surveys for the extension of its lines in the University section, in anticipation of the Alaska-Yukon Pacific Exposition, and also to meet the demands of the rapidly growing population in that section of the city.

SEATTLE, WASH.—Preliminary surveys have been commenced by Stone & Webster for a system of interurban electric roads from Bellingham south into Skagit County. Construction of the lines from Bellingham to Sedro-Woolley and to La Conner and other cities in Skagit County will be started next year.

MORGANTOWN, W. VA.—At a meeting of the stockholders of the South Park Trolley Company it was decided to apply to the City Council for a franchise to extend its lines on several streets of the city. A great part of the extension is to be on private right of way.

PEWAUKEE, WIS.—The citizens have voted to issue bonds for electric light plant.

MILWAUKEE, WIS.—Bids will be received until Dec. 20 by the Board of Public Works for electric light machinery, for the pumping station of the Kinnic River Flushing Works.

EAU CLAIRE, WIS.—It is remored that the Northwestern Lumber Company has purchased the mill dam on Otter Creek of Robert Clark. The plan of the lumber company, it is said, is to raise the dam much higher and erect a hydroelectric plant and transmit electricity to this city.

MENOMONIE, WIS.—The City Council of Menomonie and the Chippewa Valley Electric Company of this city have agreed on two franchises, one for electric lighting and the other for an electric railway. The franchises will soon be granted, and the construction of an electric railway connecting Menomonie with Eau Claire will begin in the near future.

PETERBOROUGH, ONT.—The Council is considering the construction of an electric railway from this city to Rice Lake.

BRANTFORD, ONT.—The Automatic Telephone Company is having plans prepared for a large building to be erected in this place.

OTTAWA, ONT.—Arrangements are now being made for an extension of the electric light plant here at a cost of $50,000. Address the Mayor.

TORONTO, ONT.—The Toronto Electric Street Railroad Company will build a new line to the Exhibition Grounds at an estimated cost of $125,000.

FORT WILLIAM, ONT.—The Canadian Pacific Railroad has contracted for 1,000 hp from the Kakabeka Falls Power Company for use in the company's yards here.

PORT PERRY, ONT.—Charles Calder, W. L. Parrish, James Bigelow and others of Port Perry have petitioned for permission to develop power at Buckham Rapids on the Trent River, 41 miles north of Port Perry.

ST. THOMAS, ONT.—It is reported that the Detroit United Railway Company will soon take over the Southwestern Traction Company's line between London and St. Thomas, as well as Charters to Port Stanley and other places in western Ontario.

OTTAWA, ONT.—The minister of railways has under consideration the question of getting power from the Petitcodiac for the Intercolonial Railway workshops and also sufficient power for the city of Moncton, which could be obtained by the construction of dams. The scheme is not yet perfected, but is said to be quite feasible.

TORONTO, ONT.—The Electrical Development Company, of Ontario, has purchased a right of way for its transmission line to Brantford, which city will be made a centre from which the company will extend its lines to Paris, Woodstock, Ingersoll and London, and north to Galt, Preston, Hespeler, Guelph and Berlin. Frederick Nicholls is manager.

Company Elections.

BELL OAK, MICH.—At the annual meeting of the Locke Mutual Telephone Company, held Dec. 1, the following directors were elected for the coming year: Calvin Kingsley, Martin Grout, G. D. Spencer, Sylvester Brown, Charles Chandler, William Lovejoy, Frank Bridger. The following officers were elected by the directors: Calvin Kingsley, president; Martin Grout, secretary; E. J. Doolittle, treasurer.

LACONIA, N. H.—At a meeting of the Laconia Electric Lighting Company, held recently, the directors tendered their resignations and the following officers were elected: H. L. Pierce, president; L. S. Pierce, vice-president and secretary; E. P. Hadley, Leominster, Mass., treasurer. The new board of directors consists of H. L. Pierce. L. S. Pierce, E. P. Hadley and Mrs. H. L. Pierce. L. S. Pierce was elected general manager of the company.

SHARON, PA.—The Cleveland & Sharon Traction Company, which was recently incorporated with a capital stock of $2,500,000, was organized at Sharon, Pa., by the election of the following officers: Francis B. Morgan, of Cleveland, Ohio, president; John Blake, of Brooklyn, N. Y., vice-president and secretary; C. F. Clendenning, of New York, N. Y., treasurer; P. F. Morgan, of Cleveland, Ohio, assistant secretary and treasurer.

READING, PA.—At the meeting of the Reading Power Company and the West Reading Power Company, held recently, at which the two companies were merged, the new company took the name of the Reading Power Company. The following officers were chosen: John A. Rigg, president; Remi Remont, first vice-president; W. R. McIlvain, second vice-president; T. W. Grookett, Jr., secretary and treasurer. Directors: John A. Rigg, Jos. L. Caven, William R. McIlvain, Richmond L. Jones, John H. Catherwood, John M. Frame, Frank L. Connard, Isaac Eckert, L. T. Custer, Ferdinand W. Roebling, Robert N. Carson, Remi Remont, William McIlvain, Preston Lea.

New Industrial Companies.

THE FLAMING ARC LAMP COMPANY, of New York, N. Y., has been incorporated with a capital stock of $50,000. The directors are A. L. Stone, J. R. Gray and M. Beltchick.

THE JAMESTOWN ELECTRIC MILLS, of Jamestown, N. Y., have been chartered with a capital of $50,000. The directors are F. A. Smiley, W. W. Campbell and C. E. Campbell.

THE I. A. BENNETT COMPANY has been organized at Chicago with a capital of $2,500, to deal in electrical and mechanical devices. Mr. Bennett is well known in electrical circles as manufacturer's agent.

THE ORRINGTON MOTOR COMPANY has been organized at Augusta, Me., for the purpose of manufacturing electrical apparatus, with a capital stock of $10,000. J. Berry, of Augusta, is president and treasurer.

THE LIRCH ELECTRICAL & TESTING LABORATORIES, of Los Angeles, Cal., have been incorporated with a capital stock of $75,000. The directors are: James M. White, E. J. Borgmeyer, R. B. Sumner, Harry F. Anderson and A. P. Thomson.

THE COBALT ELECTRICAL DEVELOPMENT COMPANY has been incorporated with a capital of $500,000, to supply heat, power and electricity. The incorporators are: M. P. Wright, R. P. Shillington and W. C. Young, all of Haileybury, Ont.

THE LIVERMORE PAY STATION COMPANY, of Portland, Me., has been incorporated for the purpose of manufacturing telephone and telegraph appliances. The capital stock is $500,000. The officers are: C. H. Carter, of Arlington, Mass., president; L. L. Hight, Portland, Me., treasurer and clerk.

THE ELECTRICAL SWITCH PLATE COMPANY, of Hartford, Conn., has filed a certificate of incorporation with the State Secretary, with a capital stock of $50,000. The incorporators are John Alexander, William H. Miller, Daniel H. Judd and Francis H. Peabody, of Hartford, and Oscar E. Joss, of New Haven. The corporation proposes to undertake "the manufacture and sale of a switch plate under the patented process of John Alexander; also to manufacture, buy, sell or deal in electrical specialties and general electrical appliances.

New Incorporations.

PALMS, CAL.—The Palms Light, Land & Water Company has filed articles of incorporation with a capital of $1,000,000. The incorporators are: W. R. Wheat, M. R. King, C. N. Garry and others. The company proposes to develop water for domestic and irrigation purposes and will also install a lighting system. About $100,000 will be spent in improvements.

SAN BERNARDINO, CAL.—Articles of incorporation have been filed for the San Bernardino Urban Railway Company, with a capital stock of $1,000,000, by H. E. Harris, Victor Smith, A. G. Kendall, S. S. Draper and O. L. Moorman, of Riverside. The company has been organized for the purpose of building three lines having an aggregate of 48 miles.

ATLANTA, GA.—The Macon & Albany Securities Company has been organized to build electric railways connecting Macon, Americus and Albany, Ga. The following officers were elected: Nicholas J. Cruger, president; Joseph S. Davis, vice-president; W. J. Massee, secretary and treasurer; Stuart Davis, assistant secretary and treasurer; M. Felton Hatcher, general counsel.

SYLVESTER, GA.—The Sylvester Telephone & Telegraph Company has been chartered with a capital stock of $2,500, to operate in Worth, Dougherty and other counties. T. A. Spurlin is interested.

WALLACE, IDAHO.—The Spokane-Wallace Electric Railway Company has been chartered for the purpose of constructing electric railways radiating from Wallace to Burke, Mulla, Kellogg and eventually to Spokane. The incorporators are W. J. Hall, F. F. Johnson, J. I. Gray, of Wallace, and others.

TOLONO, ILL.—The Tolono Ice, Light & Power Company has been organized with J. W. Riley as president.

ROCK, ILL.—The Simpson Mutual Telephone Company has filed articles of incorporation with the Secretary of State, with a capital stock of $2,000. The incorporators are John R. Harper, Milo Austin and J. J. Murrie.

THEBES, ILL.—Articles of incorporation have been filed with the Secretary of State for the Thebes & Cairo Telephone Company, with a capital stock of $4,000. The incorporators are: C. P. Spann, Albert Brawn and Herman Spaake.

MT. CARMEL, IND.—Articles of incorporation have been filed for the Evanston & Mt. Carmel Northern Railway Company, with a capital of $10,000.

NEWCASTLE, IND.—Articles of incorporation have been filed with the Secretary of State for the Newcastle Union Railway Company, with a capital stock of $50,000. The incorporators are Thomas B. Milliken, Charles S. Hernly, H. E. Jennings, A. G. Ogborn, Charles W. Mouch and Myer Heller, all of Newcastle.

ALGONA, IA.—The Algona Telephone Company has been incorporated with a capital stock of $50,000 by B. H. Gardiner and others.

KEOSAUQIA, IA.—Articles of incorporation have been filed for the Iowa Electric Power Company with a capital stock of $150,000 by William Walker and others.

BURLINGTON, IA.—The Gate Telephone Company has filed articles of incorporation with a capital stock of $10,000. The directors are William H. Taylor and others.

LOUISVILLE, KY.—The White City Electric Light, Heat & Power Company has filed articles of incorporation, with a capital stock of $300,000. The incorporators are: Richard D. Bakrow, C. C. McClarty and John M. Sharp.

KITTERY, ME.—Articles of incorporation have been filed for the Chemical Gas, Heat, Light & Power Company with a capital stock of $1,000,000. G. B. Blidgette is president.

Legal.

DUTY OF TELEPHONE COMPANY TO FURNISH SAFE APPLIANCES TO EMPLOYES.—An employe of a telephone company, engaged in splicing and connecting the ends of telephone cables was thrown from a swinging platform, upon which he was working at the time of the accident, to the street and killed. The accident was the result of the breaking of one of the ropes which supported the platform. The rope was one-half inch in diameter and had been stored in a place where it was exposed to ammonia fumes and muriatic acid. It was shown that either of these agencies would tend to weaken a rope so as to render it unfit for the use to which this particular rope was put. The court held that it was the duty of the telephone company to furnish its employe with a reasonably safe rope with which to perform his work; that the employe had the right to rely upon the soundness of the rope furnished for him and that he was under no duty to test or inspect it; that that duty devolved upon the telephone company. In an action, brought by the employe's administrator, the company was held liable and a verdict for $5,000 was recovered. Cumberland Telephone and Telegraph Company, Court of Appeals of Kentucky.

STOCKHOLDER'S RIGHT TO INSPECT BOOKS AND RECORDS OF CORPORATION.—The right of the stockholders of a corporation to inspect the corporate books and records was recognized at common law, and, in many jurisdictions in the United States, has been further secured by statute. It is generally held that the right cannot be annulled or abrogated by the by-laws of the corporation. At common law, or in a jurisdiction where there is no statute regulating the matter, the right to make an inspection is not absolute. It may not be exercised for the mere gratification of idle curiosity. It is upon the stockholder, demanding the right of inspection, to show that some necessity exists; that some interest is at stake. But where a by-law of a corporation expressly provides that the books and papers of the company shall be open to inspection at all times during the day, or during business hours, it is held that the effect of such by-law is to extend the common law right so that a stockholder may come into court and demand a writ of mandamus compelling the officers to allow him to inspect, without setting forth or proving the purpose for which the examination is sought.—Wyoming Coal Mining Company vs. State, Supreme Court of Wyoming.

DUTY OF ELECTRIC LIGHT COMPANIES AS TO INSULATION OF WIRES.—Electric light companies or persons operating such plants are under a legal duty to see to it that the insulation of their wires is perfect at points where people have the right to go for business purposes or for pleasure. At least this rule has been adhered to by the courts of Kentucky and has been recently reiterated in the case of Thomas vs. City of Somerset, decided by the Court of Appeals of that State. The City of Somerset owns an electric lighting plant and rented or leased for compensation to the owner a booth engaged in the candy business, an electric lamp fitted with a brass socket. An employe of the owner of the booth placed his hand upon the globe of the lamp for the purpose of warming it when one of his fingers came in contact with the brass socket resulting in painful injuries. An electrical engineer, introduced as a witness, testified that the lamp and socket were not properly insulated or protected, and that the dampness of the atmosphere added to the danger of coming in contact with the parts of the lamp. It was argued on behalf of the city that the condition of the lamp was unknown to it and that the plaintiff, not being required by his duty or business to handle the lamp, was a trespasser in so doing. It was held that the plaintiff had a right to be where he was and that the city must respond in damages for the additional reason that it had committed a breach of duty in failing to have the lamp perfectly insulated.—Thomas vs. City of Somerset, Court of Appeals of Kentucky.

Educational.

EVENING LECTURES.—Dr. C. E. Magnusson announces a series of special evening lectures by the department of electrical engineering at the University of Washington, Seattle. They are part of a regular course, and will be included in the field covered by the semester examinations. Mr. E. G. Allen will lecture on electric traction; Mr. J. D. Ross on central station practice; Mr. C. E. Fleager on telephones, and Mr. J. Harisberger on electric power transmission. These are all practical experts in their line of work and discourse, and the lectures should prove highly useful.

Obituary.

MR. W. FISHER.—The death is announced of Mr. William Fisher, the inventor of the governor that bears his name and founder of the Fisher Governor Company. He died at Marshalltown, Ia., on Nov. 29, in the sixty-eighth year of his age.

DR. W. J. HERDMAN.—Dr. William James Herdman, professor of nervous diseases and of electro-therapeutics at the University of Michigan, died at Baltimore this week at a private sanitarium, where he was operated upon a few days ago. He was fifty-eight years of age. Dr. Herdman was born at Concord, O., in 1848, and received his early education at Westminster College, Pa. He graduated at the University of Michigan in 1872 and from the medical department of the same university in 1875. He became a member of the faculty and has been professor of opathological and practical anatomy, of medical jurisprudence (in the law department), and of diseases of the mind and nervous system. Dr. Herdman held office in nearly all the great medical bodies of America, and was highly esteemed as well in electrical circles.

MR, WALLACE CLYDE JOHNSON died at his home, Cedar Avenue, Niagara Falls, N. Y., on the morning of Saturday, Dec. 15. The cause of death was dilation of the heart and kidney trouble. The electrical and engineering professions have thus lost a man who has been largely connected with the development in these fields for the past twenty years, and who is known throughout the United States, Canada and Europe as having been the possessor of unusual skill and ability in planning hydro-electric developments. Mr. Johnson was born in Granville, Mass., May 21, 1859. His early education was obtained in the common and high schools of that village. In 1882 he graduated from Williams College, and in 1884 from the Worcester Polytechnic Institute. In 1886 he became the chief engineer of the Niagara Falls Hydraulic Power & Manufacturing Company, and up to the time of his death he was connected with this company. Until 1900 he was chief engineer of the company, and since then he had been known as its consulting engineer. During the past six years Mr. Johnson has been connected with several notable hydro-electric developments in the United States and Canada. The development at Shawinigan Falls, Que., was planned by him, as were also the development at Oldtown, Me.; at Hannawa Falls in St. Lawrence Country, four miles from Potsdam; the development of the Albion Power Company at Waterport, N. Y.; the Empire State Power Company on the Schoharie Creek, off the Mohawk River, etc. Mr. Johnson had an office in Niagara Falls, as well as in New York City. He was engineer of the Niagara Falls & Suspension Bridge Street Railway Company when the first street car ilne was built in Niagara Falls, and he also planned the sewer system of that region. His map of Niagara Falls and vicinity stands among the best. In many ways and in many localities he has left monuments to his memory.. He was a member of the State Water Supply Commission, a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the Engineers' Society of Western New York, an associate member of the American Institute of Electrical Engineers, and an associate member of the Society of Arts, London, Eng. He leaves a wife, to whom he was married in Holyoke, Mass., May 31, 1893, her maiden name having been Eloise Gertrude Murlless.

Personal.

MR. P. A. YOUNG has opened an office at Charleston, W. Va., for the sale of electrical, mining and mill supplies, and invites the correspondence of manufacturers desiring to be represented in that locality. The district is one that makes a large and steady demand for apparatus.

DR. C. P. STEINMETZ numbers among his accomplishments that of horticulturist, as we are reminded by an illustration in the current issue of the *Garden Magazine*. Dr. Steinmetz has one of the rarest collections of cacti in this country, and the engraving represents him in the midst of his plants.

MR. JOHN W. KELLY, JR., formerly superintendent of equipment of the Keystone Telephone Company, of Philadelphia, has severed his connection with that company to become the general superintendent of the General Acoustic Company. He will make his headquarters in New York City and will have the entire charge of the telephone interests of the General Acoustic Company, especially the "Dictograph," a new departure in the telephonic field.

MR. W. F. WELLS.—Mr. Walter F. Wells, manager of the Edison Electric Illuminating Company, of Brooklyn, delivered a lecture last week before the department of electricity of the Brooklyn Institute of Arts and Sciences on the place of the steam turbine in an electric lighting plant. The lecture presented the latest steps in the evolution of the modern power house, and described the characteristics of the various steam turbines now being introduced in this country.

MR. EMIL KOLBEN is the subject of a biographical notice in the *Prager Tagblatt* of November, which issue is devoted to a full report of the centennial celebration of the German Institute of Technology in Prag, Bohemia, founded in 1806, as the Polytechnic Institute. Mr. Kolben on this occasion received the honorary degree of Doctor of Technical Sciences. Dr. Kolben at one time resided in this country, during which time he was in the employ of Mr. T. A. Edison and the General Electric Company.

MR. F. C. WEBER, of Fon du Lac, Wis., connected formerly with the Plattsmouth, Neb., Lighting Company, Stromberg-Carlson Telephone Co., and the General Electric Company, has accepted a position as electrical engineer and superintendent of construction for the Western Electrical Company, of Omaha, Neb. This position was made vacant by the resignation of Mr. Ralph D. Coleman, who has joined the selling forces of the Northern Electrical Manufacturing Company, of Madison, Wis., and will have headquarters at Kansas City and Omaha, as district engineer in that territory.

PROF. FRANK G. BAUM, who has been in charge of the hydraulic and electrical engineering and construction, and also the operation of the system of the California Gas & Electric Corporation for the past three and one-half years, has resigned his position, to take effect Jan. 1, 1907,

in order to go into consulting engineering, his specialty being hydro-electric power plants and long-distance transmission systems. Prof. Baum will continue as consulting engineer for the California Gas & Electric Corporation, and will have his offices on the fourteenth floor of the Chronicle Building, San Francisco, about Jan. 15. He is a member and vice-president of the American Institute of Electrical Engineers, a member of the American Society of Mechanical Engineers, and an associate member of the American Society of Civil Engineers.

Trade Publications.

TROLLEY FROGS.—The proper selection and location of trolley frogs for different services are treated in bulletin No. 4465 of the General Electric Company, Schenectady, N. Y.

SAWMILL WORK.—The General Electric Company has issued Bulletin 4470, devoted to the use of the electric motor in sawmill work, giving a good illustration, descriptive of plans of this character.

AIR BRAKES.—Bulletin No. 4467 of the General Electric Company, Schenectady, N. Y., is devoted to the emergency straight air brake system. Each part of the valve is minutely described and its function explained.

FREIGHT LOCOMOTIVES.—The American Locomotive Company, 111 Broadway, New York, has issued a 72-page catalogue illustrating and describing freight locomotives of the consolidation type weighing less than 175,000 pounds.

PORTABLE TESTING SETS.—A booklet recently issued by Queen & Co., Inc., Philadelphia, Pa., deals with portable testing sets for all uses. Each type listed is illustrated and briefly described, while the price is definitely stated.

ELECTRIC HOISTS.—The Truxel-Painter Manufacturing Company, Chattanooga, Tenn., has issued a bulletin illustrating and describing the Painter hoist for handling brick, mortor and concrete in wheelbarrows. The hoist is driven by either an electric motor or a gasoline engine, and is stated to be light, reliable and fool-proof.

JAEGER LAMPS.—The Jaeger Miniature Lamp Manufacturing Company, Bible House, New York City, is bestowing happiness on many thousand children this Christmas with its beautiful miniature lamps, used on trees and in illuminative decorations of all kinds. It issues some very attractive illustrated literature on the subject.

MINE LOCOMOTIVES.—Electric mine locomotives are the subject of a large and handsome pamphlet issued by the power and mining department of the General Electric Company. It has 53 pages of text and several pages of specifications, the whole constituting a most valuable record and argument.

THE WESTERN ELECTRIC COMPANY, as was noted in these columns, has erected an immense factory at the extreme west of Chicago, known as the Hawthorne Works. A well-illustrated description of the buildings and their equipments is contained in a bulletin recently issued by the company.

THE SPRAGUE ELECTRIC COMPANY, of 527 West Thirty-fourth Street, New York, City, has issued a handsome pamphlet devoted to its fine equipment in the new Hotel Gotham, this city. It comprises three generators of 160-kw and one 75-kw direct-connected, and some 30 motors from ¼ to 40 hp distributed through the building for a variety of service. Parts of the plant are clearly illustrated and the whole installation is well described.

News of the Trade.

THE CONSOLIDATED CAR HEATING COMPANY, Albany, N. Y., has entered the electric train lighting field and is engaged in perfecting a line of generating apparatus for this purpose. An indication of the character of construction employed by the company may be gained from the brief description and sectional illustration on page 1078 of our issue for December 1, which show that the dynamo, which was built by this company, is provided with Hess-Bright ball bearings.

VULCAN BRANDER.—The Vulcan Electric Heating Company, 71 West Jackson Boulevard, Chicago, has brought out a handy meat inspection brander. This is an electric branding iron heated red hot by electricity and employed at the Chicago stock yards. A man uses one of these tools in each hand and brands meat carcasses which pass at the rate of 1,000 per hour. The continuous flow of current keeps the brand hot all day long and there is no equally good method. President Holmes states that the brander is a great success.

CORPORATION CONTRACTS.—Messrs. W. T. Hunt & Son, of 150 Nassau street, New York City, have been made special agents for the sale of the valuable publication, Mann on the Law of Foreign Business Corporations Doing Business in the State of New York. All that the unprofessional reader, whether he is a corporate officer or not, needs to know about the law of this State, civil and criminal, as it applies to any manufacturing or business corporation of another State or country, authorized to transact business in New York, is set forth in the 500 pages of this useful compendium.

THE CLEVELAND GAS AND ELECTRIC FIXTURE COMPANY, Rose Building, Cleveland, O., has lately put on the market an innovation in the fixture trade, which it calls "C" box line fixtures. These goods are boxed in a small package which is convenient for carrying in stock on shelves, and they are being received with favor by the trade. The company is building a new factory at Conneaut, O., with double the floor space of its present one in Cleveland, under conditions that enable it to produce these fixtures at a low cost. Part of this factory is already in operation, and it has been selling fixtures, illustrated in a special booklet, for about three months. Copies of the booklet can be had upon application.

UNITED INDURATED FIBRE CO., Lockport, N. Y., furnished some time ago to the Oneida Railway Company, which has the contract for electrifying the West Shore Railroad between Utica and Syracuse, all the ten-mile installation of the W. & S. underrunning third-rail cover. Their superintendent has expressed himself as being very highly pleased with the material, saying that there was no loss in handling the covering that could be attributed to the manufacture. After a few hours work, the men become accustomed to it. Hence the cover was installed at an even less cost than expected, and had the Fibre Company been in a position to fill a larger order, it would have been awarded to them. Covering the ends of rails where they terminate at crossings has been a source of considerable anxiety, and they must be thoroughly insulated and protected to avoid danger. This now seems to have been accomplished by making a reinforced rail and cover that is very substantial and fits the rail so precisely that it can be removed only with difficulty.

Weekly Record of Electrical Patents.

UNITED STATES PATENTS ISSUED DEC. 11, 1906.

[Conducted by Rosenbaum & Stockbridge, Pat. Attys., 140 Nassau St., N. Y.]

837,941. AUTOMATIC FIRE ALARM; James H. Marchant, Schenectady, N. Y. App. filed Apr. 20, 1906. A spring blade is supported by a base and is held in conducting relation against a metallic clip so as to close a circuit, by means of a small paraffin block. When the temperature rises the circuit is broken and an alarm given.

837,994. MAGNETIC SEPARATOR; James C. Winder, East Point, Ga. App. filed May 5, 1906. A plurality of soft iron strips or bars are arranged in a parallel series on a flat surface or table and the bars are energized with opposite polarity so as to attract and hold magnetic particles.

838,005. ELECTRICAL CIRCUIT INTERRUPTER; Albert M. Bullard and William H. Matthies, New York, N. Y. App. filed Sept. 9, 1905. In order to produce a busy test signal which will not be confused by the ordinary hum of telephone circuits, patentee has relay cores with copper tubes thereon which gives a very sluggish action, so that the vibration of the relay is very slight.

838,006. AUTOMATIC-EXCHANGE CIRCUIT; Albert M. Bullard, New York, N. Y. App. filed Mar. 10, 1906. Relates to details of circuits for an automatic exchange having trunk lines.

838,017. FORMER FOR ARMATURE COILS; William H. Foot, Wilkinsburg, Pa. App. filed May 8, 1905. A cast iron drum has metallic clamps adjustably arranged thereon and which can be positioned in various ways so as to constitute a former for armature coils of different sorts.

838,021. CONTROLLING MEANS FOR ELECTRIC MOTORS; Fletcher D. Hallock, Wilkinsburg, Pa. App. filed June 2, 1905. Details of the circuits of a car controller designed to adjust the amount of resistance included in the field circuit of a motor without changing the predetermined arc of rotation of the controller handle in its normal use.

838,028. PHANTOM TELEPHONE SYSTEM; Thomas P. Jordan, Dallas, Tex. App. filed Oct. 3, 1904. Has phantom circuits connected to the main circuits by points of approximately equal potential and inductive means for causing silence in the receivers of the local circuits to prevent cross conversation.

838,034. ELECTRICAL MACHINE; Benjamin G. Lamme, Pittsburg, Pa. App. filed Feb. 21, 1905. In an electrical machine, a core having two concentric sets of slots and two sets of conductors located in said slots and connected together, the number in the inner slot bearing a definite relation to the number in the outer set.

838,066. ELECTRICAL PROTECTIVE DEVICE; Charles E. White, Chicago, Ill. App. filed Jan. 9, 1905. In an electrical protective device, in combination, a circuit-opener; and means for operating said circuit-opener, comprising a bell-shape air chamber, and a resistance-coil surrounding the smaller end of said chamber.

838,048. ELECTRIC MOTOR; Samuel L. Nicholson, Pittsburg, Pa. App. filed Sept. 25, 1905. Relates to a motor adapted to operate a "Jordan Engine" for grinding wood pulp. The ordinary Jordan engine requires a longitudinal displacement of its shaft in action and the motor is constructed with a long armature to permit this.

838,090. AUTOMATIC SWITCH MECHANISM; Augustus C. Durdin, Jr., Chicago, Ill. App. filed Jan. 13, 1906. A diaphragm is spring impelled to a balanced condition against the reservoir pressure and is connected to the switch arm. The spring is arranged to cause an abrupt movement in either direction.

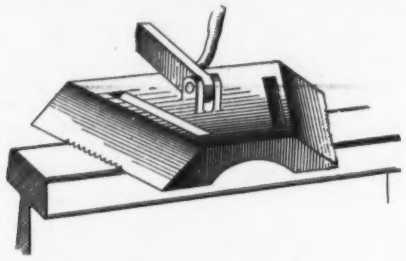
838,115. TELEPHONE-METER; Newman H. Holland, Brookline, Mass. App. filed Jan. 31, 1902. Details of a meter adapted to be located at the subscribers' stations.

838,117. TELEPHONE-SIGNAL; Thomas P. Jordan, Dallas, Tex. App. filed June 15, 1906. In a telephone comprising a bell-ringing circuit and a talking-circuit, a movable signal, means actuated by a current passing over said bell-ringing circuit for permitting said signal to move into an operative position, and means actuated by a current passing over said talking-circuit for restoring said signal to an inoperative position, substantially as described.

838,133. SINGLE PUSH BUTTON AUTOMATICALLY CONTROLLED ELECTRIC ELEVATOR SYSTEM; Frederick W. Newell, Hastings-upon-Hudson, N. Y. App. filed June 19, 1905. Provides means for automatically reducing the speed of an elevator car and varying such reduction of speed in accordance with the load as the car approaches the point at which it is desired to be stopped.

838,136. COMBINED TELEPHONE AND DISTRICT MESSENGER SYSTEM; James G. Nolen, Chicago, Ill. App. filed Nov. 26, 1902. A call box or recorder bridged across line wires and has a ground connection whereby the central operator may employ the usual busy test for operating the signal and the recording mechanism.

838,139. TELAUTOGRAPH APPARATUS; Foster Ritchie, Acton Hill, London, England. App. filed Mar. 12, 1904. Relates to means for



838,177.—Electrical Contact Shoe.

raising the usual pen from the paper in a telautograph apparatus. The lifting magnet is in shunt with a microphone contact which presents a greater resistance when the circuit is transmitting the vibratory impulses than otherwise.

838,141. SIGNAL APPARATUS; Hermann Sandvoss, Neuss, Germany. App. filed Apr. 5, 1906. A cylinder or tube contains a liquid which expands against a piston and moves a pair of contacts together. The device is adapted to be used in machinery, for example, in pitman connections, so as to give an alarm in case the heat becomes excessive.

838,144. DYNAMO-ELECTRIC MACHINE; William Stanley, Great Barrington, Mass. App. filed May 22, 1905. In a dynamo-electric machine, the combination of rotor and stator windings connected together, and means external to said windings for inducing upon the circuits thus formed alternating electromotive forces competent to urge alternating magnetizing-currents through them.

838,160. COMPOUND BRAKE FOR CARS; William D. Baldwin, New York, and August Sundh, Yonkers, N. Y. App. filed Mar. 7, 1905. The car axles have magnetic clutches which are directly connected to operate the brakes and additional connections lead to the usual hand levers so that the brake is separately operable thereby. There is also a solenoid magnet for applying the brakes.

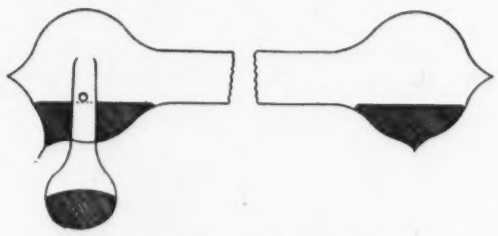
838,163. HIGH-TENSION INSULATOR; Frank G. Baum, San Francisco, Cal. App. filed Oct. 24, 1905. A type of insulator for high potential circuits adapted to be efficient under all conditions in dry and in wet weather. The patentee has two separate insulating systems which leakage currents have to traverse in series, one of which is washed by the rains and the other of which is petticoated. Leakage currents cannot traverse the dirt of the petticoated portion by reason of the weather washed insulator, but the petticoated insulator is sufficient to protect against leakage when the weather washed insulator is wet.

838,165. BATTERY-CELL; John W. Brown, Cleveland, O. App. filed June 4, 1906. In a battery-cell, a zinc electrode comprising a bottom disk and an upright call which is formed by bending a strip of zinc into substantially cylindrical form and overlapping its upright edges, said strip being unattached to said disk at and for a considerable distance from said overlapping edges thereof.

838,171. ELECTRIC SWITCH BASE; Nathan W. Crandall, Hartford, Conn. App. filed Feb. 27, 1906. In order to avoid a defect of switch construction arising on account of wear of the base by the square shaft ordinarily employed therein, the patentee has a specially formed recess which co-operates with a correspondingly shaped washer on the shaft.

838,175. CONTROLLER FOR THE TROLLEY POLES OF ELECTRIC CARS; Alfred J. Edwards, Auckland, New Zealand. App. filed Aug. 22, 1906. A weight is contained in a casing and is normally held in raised position by latches or detents. In case the trolley pole leaves the wire, the detents are released and the weight falls to retrieve the pole.

838,177. ELECTRICAL CONTACT-SHOE; Thomas Fildes, Richmond Hill, N. Y. App. filed Feb. 20, 1906. The contact shoe is made with



838,280.—Mercury-Vapor Lamp.

serrated edges inclined to the direction of movement of the shoe so as to constitute a scraper to remove ice and snow from the rail.

838,192. TELEGRAPHIC RELAY; Isidor Kitsee, Philadelphia, Pa. App. filed Feb. 26, 1906. A device for translating the movements of a siphon-recorder into ordinary Morse Code signals at a sounder. A non-conducting vane is moved in a conducting solution so as to vary the resistance thereof between fixed contacts or electrodes.

838,216. EXPLOSIVE COHERER-POWDER; Ferdinand Schneider, Langenfeld, Germany. App. filed Oct. 5, 1905. A filling for wave-responsive devices, consisting of an intimate mixture of an explosive with powdered conducting material.

838,235. ELECTRIC FUSE; Leonard B. Buchanan, Woburn, Mass. App. filed Apr. 2, 1906. In order to avoid explosion of fuses and their injury by oxidation, the patentee encloses the fusible material in amorphous silicic oxid.

838,244. AUTOMATIC RINGING DEVICE FOR TELEPHONE-EXCHANGE SYSTEMS; William W. Dean, Elyria, O. App. filed Jan. 16, 1906. In a telephone-exchange system, a source of ringing-current, a ringing-key, and a thermic controller therefor included in circuit with the source of ringing-current.

838,251. SPARK COIL BOX FOR MOTOR VEHICLES; Russell Huff, Detroit, Mich. App. filed Sept. 27, 1906. An ordinary coil box adapted to be supported on the dash of an automobile contains two coils and a switching device or commutator by which either of the coils may be put in the ignition circuit.

838,260. BINDING POST; Ray H. Manson, Elyria, O. App. filed Nov. 11, 1905. Details of the terminal clips or connections for a telephone receiver. Has a flat piece of metal bent upon itself to form two limbs with an opening to receive the circuit terminal, and means for forcing the limbs together.

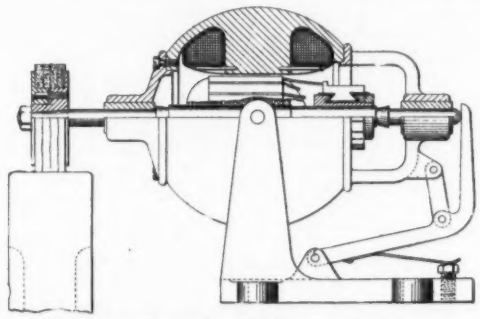
838,280. MERCURY-VAPOR LAMP; Hans Viggo Siim-Jense, Copenhagen, Denmark. App. filed Apr. 25, 1905. A mercury vapor lamp has an auxiliary vessel or chamber from which the mercury is displaced when the tube is tilted and means whereby the mercury re-enters said auxiliary chamber slowly so that it is withdrawn from the tube portion slowly and the arc gradually lengthened.

838,283. ELECTRICALLY PROPELLED VEHICLE; Russell Thayer and Joseph Ledwink, Philadelphia, Pa. App. filed May 24, 1906. A vehicle has a trolley pole and depending rollers which are adapted to run on track rails to make contact therewith. When the track is not available the rollers are raised and the vehicle proceeds on storage batteries.

838,304. LIGHTNING ARRESTER; Frank B. Cook, Chicago, Ill. App. filed May 9, 1906. Instead of mica as an insulating medium for the two carbon blocks of a lightning arrester, the patentee makes use of celluloid which will soften or melt in case the arc continues for a long period.

838,315. CONTROL OF ELECTRIC MOTORS; William Geipel and Frederick M. T. Lange, Southwark, Eng. App. filed Jan. 15, 1906. Relates to circuit controlling means for motors which run heavy machinery such as printing presses and gun turrets. The controller is designed to produce a heavy starting current which is subsequently reduced at the later contacts so that the motor does not accelerate unless this is desirable.

838,346. METHOD OF ELECTROPLATING; Evan L. Livingston, Mulhall, and William McNulty, Allegheny, Pa. App. filed Jan. 25, 1906. The method of electroplating, consisting in holding the article by suction and protecting one face thereof, and electroplating another



838,393.—Governing Device for Dynamos.

face thereof while the article is so held by vacuum; substantially as described.

838,362. RECEIVER FOR TELEPHONES; Louis Steinberger, New York, N. Y. App. filed Jan. 16, 1905. A telephone-receiver, comprising a core of insulating material, an outer metallic casing encircling the same, a locking member connected to one end of said core and engaging the adjacent end of said metallic casing, and a cap connected to the other end of said core and engaging the end of said casing adjacent thereto.

838,372. GALVANIC BATTERY; Benjamin J. Blameuser, Chicago, Ill. App. filed June 7, 1905. A galvanic battery comprising a container wherein is a chamber to receive depolarizing fluid, a holder above the container and adapted to receive a supply of such fluid and conduits extended, respectively, from the upper and lower parts of said holder to the respective upper and lower parts of said chamber for supply and discharge of fluid.

838,390. WATER PURIFYING APPARATUS; Albert E. Dietrich, Washington, D. C. App. filed Oct. 11, 1906. A receptacle has a spiral passage or channel through which the water may flow and conducting plates are arranged on the wall of the passage so as to expose the water to an electric current.

838,393. GOVERNING DEVICE FOR DYNAMOS; Charles A. Eck, Newark, N. J. App. filed Aug. 12, 1903. A friction drive for a dynamo which is operated by the potential of the circuit. The purpose is to drive the dynamo so as to get an absolutely constant electromotive force.

838,404. RELAY; Max R. Hanna, Schenectady, N. Y. App. filed May 26, 1906. Relates to details of a signal relay adapted to operate on dephased alternating currents so as not to be operated by the power currents. Has a winding supplied with current from the track circuit and another winding energized from the alternating power circuit which produces two fluxes threading the member on opposite sides of the first flux.

838,407. SAFETY DEVICE FOR BOOSTERS; John D. Hilliard, Jr., Glens Falls, N. Y. App. filed July 2, 1904. The shaft of the booster has a friction arm or detent bearing thereagainst so as to be moved in case the shaft reverses its rotation. This part is connected to circuit opening means so as to prevent damage from current reversals.

838,423. METHOD OF PRODUCING ELECTRIC COILS; Isidor Kitsee, Philadelphia, Pa. App. filed June 15, 1906. A plan for constructing magnetic coils without wire. Patentee mounts copper discs on insulating sheets and cuts a spiral slot in each so as to produce a continuous spiral conductor. These conductors are afterwards assembled in the ordinary wafer arrangement.

838,482. INSULATOR FOR LINE CONDUCTORS; James M. Weed, Denver, Col. App. filed Aug. 10, 1905. Electrodes of a high potential insulator designed to be strong mechanically and have good insulating properties. Has two series of petticoats which are connected together by a tubular form of support.

838,495. BLOCK SIGNAL APPARATUS; Alexander Bevan, Providence, R. I. App. filed Oct. 25, 1906. A block signal system for single track trolley roads having turnouts. Has ratchet wheels in the signal boxes which are engaged by pawls so as to allow a certain number of cars to enter a block and continue to display the signals until all of such cars have left the block.